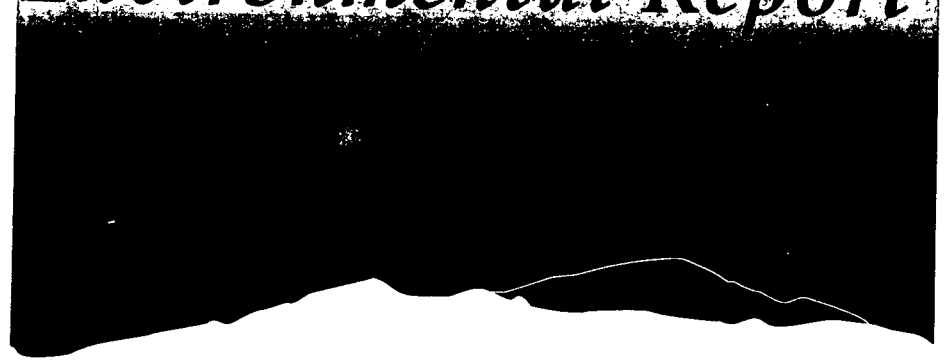
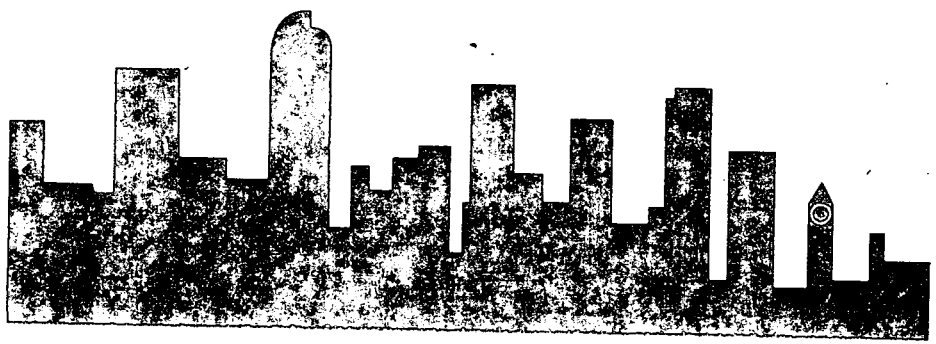
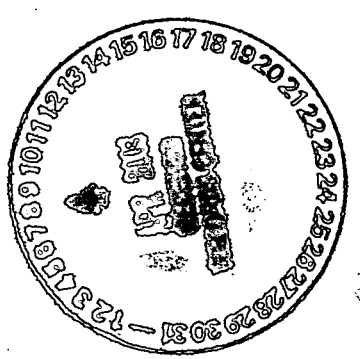
Rocky Flats Plant Site Environmental Report





JANUARY THROUGH DECEMBER 1989

Prepared for the United States
Department of Energy
der Contract DE-AC04-90 DP62349



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Work performed under the auspices of the U. S. Department of Energy under contract DE-AC04-90DP62349.

RFP-ENV-89

Rocky Flats Plant Site Environmental Report For 1989

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Plant Site Report - '89 EG&G ROCKY FLATS

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A special thank you to N. M. Daugherty and M. Van Der Puy (DOE) for their critique of the draft and final versions of this report.

EXECUTIVE SUMMARY

D. B. COSTAIN

EXECUTIVE SUMMARY

The "Rocky Flats Plant Site Environmental Report for 1989" contains a compliance summary and results of environmental monitoring, including radiation dose assessments. This section is an overview of these topics and mirrors a more comprehensive discussion found in the main text of the report.

Compliance Summary

National Environmental Policy Act (NEPA)

The Rocky Flats Plant (RFP) created a NEPA Compliance committee in February 1989 to provide integrated review, guidance and oversight for plantwide activities. Draft Environmental Assessments (EAs) DOE/EA-0413, "Interim Remedial Action at the 881 Hillside Area," and DOE/EA-0432, "Supercompactor and Repackaging Facility and Tru Waste Shredder," were submitted to the Department of Energy (DOE) for review and approval. No draft or final Environmental Impact Statements were issued in 1989. NEPA documentation is required for major federal actions significantly affecting the quality of the human environment.

Clean Air Act

Radionuclide air emissions from RFP were 0.92 percent (%) of the Environmental Protection Agency's (EPA) National Emission Standards for Hazardous Air Pollutants (NESHAP) for whole body dose equivalent and 8.8% of the standard for an individual organ. NESHAP standards set yearly limits of 25 and 75 millirem (mrem) whole body and individual organ dose equivalents, respectively.

The calculated beryllium discharged from RFP in 1989 was 4.94 grams (g) compared to the daily limit of 10 g over a 24-hr period set by Colorado Air Quality Control Regulation #8. This regulation sets work and ambient air standards and emissions limits for various hazardous air pollutants and is administered by the Colorado Department of Health (CDH). RFP submitted 13 Air Pollution Emission Notices (APEN) to CDH in 1989. A new plantwide emissions survey began in 1989 and will continue through 1990. APENs are required by Colorado Air Quality Regulation #3 as part of an application for a new or modified emissions source releasing any contaminant classified as odorous, hazardous, or toxic.

Clean Water Act

The National Pollutant Discharge Elimination System (NPDES) permit for RFP expired and was administratively extended by the EPA in June 1989 to allow preparation of a new permit. Application for renewal of this permit was filed previously in December 1988. RFP did not exceed NPDES limits in 1989. The NPDES permit governs releases of chemical and biological pollutants into surface waters.

The Spill Prevention Control and Countermeasures/Best Management Practices Plan (SPCC/BMP) was updated in 1989 to address changes coincidental with renewal of the NPDES permit. The SPCC/BMP is required by EPA as a condition of the NPDES permit.

Colorado Water Quality Control Commission (CWQCC) adopted temporary water quality standards in July 1989 for Walnut Creek and Woman Creek. These standards set limits for organic and inorganic chemicals, metals, radionuclides, and certain physical and biological parameters. RFP did not exceed these limits in 1989.

An estimated 4.3 kilograms (kg) (9.5 pounds [lb]) of chromic acid was inadvertently discharged from a waste holding tank on February 22, 1989, to holding ponds and spray irrigation fields where runoff reached Pond B-5. Discharges from this pond would normally reach a municipal water supply, Great Western Reservoir. Discharge from this incident was diverted around the reservoir to a small lake not used for drinking water. To prevent future occurrences, a liner was installed in the secondary containment area under the waste

tanks, the control system was renovated, the waste tank alarm system upgraded and a recycle pump installed for waste tank sampling.

Atrazine was detected in surface water ponds at levels of 5 to 46 parts per billion (ppb) and was believed to originate from applications of the herbicide during a vegetation control program at RFP. Use of Atrazine was discontinued at RFP in 1989. Granular activated carbon adsorption treatment was used to remove the Atrazine prior to discharge of the water offsite.

Toxic Substances Control Act (TSCA)

Twenty-five transformers and 300 capacitors were replaced at RFP to remove oils contaminated by polychlorinated biphenyls (PCBs). Asbestos contaminants originating from building insulation were managed according to applicable TSCA standards. TSCA authorizes testing and regulation of chemical substances entering the environment; at RFP compliance is directed at management of PCBs and asbestos.

Resource Conservation and Recovery Act (RCRA)

As a result of Settlement and Compliance Order #89-07-10-01 among CDH, DOE, and Rockwell International, a consolidated RCRA Part A permit application was submitted to CDH in August 1989 which included all hazardous, low-level mixed, and transuranic mixed waste managed at the plant. The Part A permit application identifies facility location and operator, hazardous wastes to be managed and hazardous waste management methods.

Separate RCRA Part B permit applications were submitted for hazardous/low-level mixed waste (December 1987) and transuranic mixed waste (July 1988). A draft RCRA operating permit has been prepared by CDH for 9 of 20 hazardous and low-level mixed waste units and a proposed Notice of Intent to Deny (NOID) was prepared for the remaining 11 units. RFP provided comments to CDH on the draft permit on December 18, 1989, and the public comment period was extended to March 30, 1990, to allow RFP to submit additional information for waste units included in the NOID. The permit application for transuranic mixed waste is under review by CDH. The RCRA Part B permit includes a detailed narrative description of all facilities and procedures related to hazardous waste management.

RFP submitted eight RCRA interim-status closure plans in 1989 for outdoor storage pads, internal building areas and storage tanks. Implementation of closure plans continued with efforts focused on the Solar Ponds, Present Landfill, West Spray Field and Original Process Waste Line areas. All interim-status closure plans were combined under the designation of Operable Unit No. 3 by the Interagency Agreement. RCRA closure plans identify procedures for removing hazardous waste management units from service and programs to remove both short- and long-term threats to human health and the environment.

RFP submitted 23 RCRA Contingency Plan Implementation Reports in 1989. RCRA Contingency Plan Implementation Reports are submitted as a result of incidents involving hazardous wastes at RFP.

In June 1989, Compliance Order #89-06-07-01 was received from CDH for alleged violations concerning inadequate ground water monitoring and quality assessment for hazardous wastes. RFP submitted a ground water assessment plan in September 1989 in response to this compliance order.

In July 1989, Settlement Agreement and Compliance Order #89-07-10-01 was reached affecting storage of low-level and transuranic mixed wastes. A limit of 1,601 cubic yards of transuranic mixed wastes was set for RFP.

In September 1989, DOE, CDH, and EPA signed a Federal Facilities Compliance Agreement and Compliance Order on Consent that provides a 1-yr period for DOE to work toward achieving compliance with the land disposal restrictions. Required actions include accurate identification, safe storage, identification of treatment methodologies, and minimization of wastes prohibited from land disposal.

In November 1989, DOE, CDH, and EPA signed Settlement Agreement and Compliance Order on Consent #89-10-30-01, regarding alleged failures to implement proper waste management procedures for onsite process residues. Required actions include residue classification, characterization, and RCRA compliance.

The Rocky Flats Waste Minimization Program realized an 80% reduction in the use of 1,1,1-trichloroethane and Freon-113 from the beginning of the program in 1988 through 1989. Recycled waste paper increased from 51.4 tons in 1988 to 116.7 tons of paper and 60 tons of cardboard in 1989.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

RFP submitted several reports and work plans reflecting phased implementation of CERCLA corrective action response requirements for the 881 Hillside and 903 Pad, Mound and East Trenches areas. An Interim Measures/Interim Remedial Action Plan for the 881 Hillside Area was submitted and public comments received. RFP was added to the EPA National Priorities List of CERCLA sites in 1989. CERCLA requires an investigation and remediation of sites contaminated by past hazardous waste management activities.

Emergency Planning and Community Right-to-Know Act (EPCRA)

RFP submitted the "Tier II Emergency and Hazardous Chemical Inventory Forms" report to emergency planning agencies for the State of Colorado, Jefferson and Boulder counties and the RFP Fire Department in 1989. This report is required under Section 312 of EPCRA and lists quantities and locations of hazardous chemicals.

RFP submitted the "Toxic Chemical Release Inventory" to EPA as required under Section 313 of EPCRA. This report contains information on routine and accidental releases of chemicals in 1989, maximum amount of chemicals stored and amount of chemicals contained in wastes transferred offsite.

Interagency Agreement

A draft Interagency Agreement was negotiated among EPA, CDH, and DOE as the framework for environmental restoration activities at RFP. The Interagency Agreement divides solid waste management units at RFP into ten operable units for study and cleanup purposes. The agreement also specifies delivery of major reports and project management details, including community involvement and decision-making responsibilities among represented agencies.

Agreement in Principle

An Agreement in Principle was completed between DOE and the State of Colorado that identifies additional technical and financial support to Colorado for environmental oversight, monitoring, remediation, emergency response, and health-related initiatives associated with RFP. The agreement also addresses RFP environmental monitoring initiatives and accelerated cleanup activities where contamination may present an imminent threat to health or the environment.

Settlement Agreement (Church vs. DOE et al.)

Further tillage and seeding with irrigation will be initiated in 1990 in an attempt to revegetate areas adjacent to the eastern boundary of RFP where previous plowing to remediate plutonium contamination in soils has occurred. Plutonium concentrations have been reduced to within the State of Colorado standard (2.0 disintegrations per minute per gram [dpm/g]) for areas where remedial plowing has been conducted. Remediation was required under a Settlement Agreement reached in 1984 between DOE, Dow Chemical Company, Rockwell International, local governments and private landowners.

Environmental Monitoring

Special Assignment Team

A Special Assignment Team was mobilized by DOE to provide an independent evaluation of operations and practices at RFP. The environmental portion of the audit focused on determining whether RFP activities created an imminent threat to the public or environment, whether operations were conducted in accordance with environmental requirements and best management practices, and the status of previously identified environmental problems. Findings of the audit were addressed in an action plan prepared by EG&G Rocky Flats, Inc. The plan described measures to resolve deficiencies together with associated schedules, costs, and responsible parties. The Five-Year Plan and Site-Specific Plan provided additional, detailed information on budgets and schedules for environmental compliance and cleanup activities at RFP.

Air Monitoring

Effluent Air Monitoring

Particulate samples were taken from ventilation exhaust systems in research and production facilities and were analyzed for alpha-emitting radionuclides (uranium, plutonium, and americium), tritium and beryllium. Plutonium and uranium discharges totaled 5.12 microcuries (μCi) (1.88 x 105 becquerels [Bq]) and 7.62 μCi (2.82 x 105 Bq), respectively. Maximum sample concentration for plutonium was 0.145 x 10^{-12} μCi/ml (5.37 x 10-3 becquerels per cubic meter [Bq/m3]) and for uranium was 0.218 x 10-12 microcuries per milliliter (μCi/ml) (8.07 x 10-3 Bq/m-3). These maximum concentrations were observed in Building 881 Annex following a change of High Efficiency Particulate Air (HEPA) filters and probably occurred when residual contamination was displaced and leaked past filters. Americium discharges totaled 1.18 μCi and maximum concentration was 0.03314 x 10^{-12} μCi/ml measured in December. Total tritium discharged was 0.177 curies (Ci) (6.48 x 109 Bq). Maximum tritium concentration was 14,000 x 10-12 μCi/ml (5.18 x 102 Bq/m3) observed in April. Total beryllium discharged in 1989 was 4.95 g compared to a State of Colorado standard of 10 g per 24-hr period. Beryllium was not significantly above background levels. Radionuclide releases did not exceed NESHAP limits based on computer modeling using the AIRDOS/EPA and RADRISK computer codes.

Nonradioactive Ambient Air Monitoring

Ambient air was sampled for total suspended particulates (TSP), and respirable particulates (Particulate Matter-10 [PM-10]), in 1989. TSP and PM-10 samplers were co-

located on RFP and sampling was concurrent. The highest TSP value (24-hr sample) was 80 micrograms per cubic meter ($\mu g/m^3$) and the annual geometric mean value was 53.5 $\mu g/m^3$. Maximum PM-10 value (24-hr sample) was 42.5 $\mu g/m^3$ and the annual geometric mean was 20.9 $\mu g/m^3$. Annual geometric means for TSP and PM-10 samplers were 71 and 42%, respectively, of National Ambient Air Quality Standards (NAAQS).

Radioactive Ambient Air Monitoring

Ambient air samplers monitored airborne plutonium in environs around RFP. Stations were located on RFP, along the property perimeter and within nearby communities. Overall mean plutonium concentration measured for onsite samplers was 0.367×10^{-15} µCi/ml (0.136×10^{-3} Bq/m³), equal to 1.8% of the Derived Concentration Guide (DCG). Overall mean plutonium concentrations for perimeter and community locations were each 0.001×10^{-15} µCi/ml (0.370×10^{-4} Bq/m³), less than 0.006% of the DCG.

Surface Water Monitoring

Rocky Flats Plant Site Surface Water Monitoring

Discharges from ponds located on North Walnut Creek, South Walnut Creek and Woman Creek were analyzed for a suite of chemical, biological and radiological parameters subject to limitations of the NPDES permit and CWQCC temporary water quality standards. Neither NPDES nor CWQCC standards were exceeded in 1989.

Highest volume-weighted average concentrations and percent of DCG for plutonium, uranium, americium, and tritium were as follows:

	Average Concentrations ($\times 10^{-9}$ µCi/ml)	Percent of DCG
Plutonium (Pond C-2)	0.019 ± 0.018	0.06%
Uranium (Pond A-4)	6.41 ± 0.12	1.28%
Americium (Pond B-5)	0.013 ± 0.008	0.04%
Tritium (Pond C-1)	30 ± 50	0.002%

Samples of raw water supply for RFP were taken from Ralston Reservoir and South Boulder Diversion Canal. Mean concentrations and percent of DCG for plutonium, uranium, americium, and tritium were as follows:

	Average Concentrations ($\times 10^{-9}$ µCi/ml)	Percent of DCG
Plutonium	0.007 ± 0.013	0.023%
Uranium	0.99 ± 0.41	3.3%
Americium	0.000 ± 0.008	0.0%
Tritium	30 ± 90	0.002%

Community Surface Water Monitoring

Samples were taken of public water supplies and drinking water from several surrounding communities. Maximum average reservoir and drinking water concentrations and percent of DCG for plutonium, uranium, americium, and tritium were as follows:

PUBLIC WATER SUPPLIES

	Maximum Average Reservoir Concentrations ($\times 10^{-9}$ µCi/ml)	Percent of DCG
Plutonium (South Boulder Diversion Canal)	0.053 ± 0.039	0.177%
Uranium (Ralston Reservoir)	2.75 ± 0.16	0.55%
Americium (Ralston Reservoir)	0.023 ± 0.032	0.076%
Tritium (Ralston Reservoir)	40 ± 150	0.002%

DRINKING WATER

	Maximum Average Drinking Water Concentrations ($\times 10^{-9}$ µCi/ml)	Percent of DCG
Plutonium (Arvada)	0.003 ± 0.02	0.01%
Uranium (Thornton)	1.54 ± 0.64	0.31%
Americium (Denver)	0.024 ± 0.033	0.08%
Tritium (Louisville)	130 ± 140	0.007%

Ground Water Monitoring

Ground water samples were collected quarterly and analyzed for a suite of chemical and radionuclide parameters. Emphasis was placed on defining the magnitude and extent of contamination occurring at identified environmental restoration sites. Contamination appears confined to local areas adjacent to past and present processing, storage, and disposal sites. These areas are not believed to pose an immediate threat to public waters.

Operable Unit 1 (881 Hillside) is contaminated with volatile organic compounds (VOCs) in the shallow ground water system. Concentrations of trichloroethene (TCE), tetrachloroethene (PCE) and 1,1,1 trichloroethane (1,1,1 TCA) ranged up to 11,000 micrograms per liter (µg/l), 5,900 µg/l and 15,000 µg/l, respectively, although these concentrations were very limited in areal extent. Total Dissolved Solids (TDS), certain major ions and metals (strontium, selenium, and uranium) were above background levels. Uranium values ranged up to 53 picocuries per liter (pCi/l).

Contamination at Operable Unit 2 (903 Pad, Mound Area, and East Trenches) occurred in the surficial ground water system and consisted of elevated levels of TCE, PCE and carbon tetrachloride (CCl_4). TCE concentrations ranged to 12,000 µg/l, though for a very limited area. The geometric mean concentration of TCE for 10 wells was 107 µg/l. Concentrations of PCE were highest at the Mound Area (45,000 µg/l) but diminished rapidly to the east and south. Carbon tetrachloride contamination was highest in the East Trenches and 903 Pad area ranging to 1,100 µg/l and having a geometric mean of 400 µg/l for the second quarter of 1989.

Operable Unit 3 consists of the Solar Ponds, West Spray Field, and Present Landfill. Maximum concentrations of contaminants in the surficial ground water system at the Solar Pond area occurred near the immediate site and diminished rapidly downgradient. Maximum concentrations of TDS (17,400 milligrams per liter [mg/l]), nitrate (12,100 mg/l), uranium (428 pCi/l), and tritium (9,000 pCi/l) were observed. Other elevated parameters included strontium, sodium, magnesium, chloride, and sulfate. Concentrations of nitrates were elevated in one alluvial ground water well in the West Spray Field (up to 20 mg/l). Nitrate values for other wells in this area did not exceed 10 mg/l. Contamination of alluvial ground water within the Present Landfill consisted of elevated values of TDS (597 mg/l), strontium (0.67 mg/l), iron (5.4 mg/l), manganese (3.9 mg/l), and uranium (18.4 pCi/l). Contamination did not extend past the boundaries of the Present Landfill and apparently had not impacted bedrock water quality.

Soil Monitoring

Soils were sampled at 40 sites located in two concentric circles of approximately 1.6 and 3.2 kilometers (km) (1.0 and 2.0 mi) radii from the center of RFP. Plutonium concentrations ranged from 0.04 to 8.56 picocuries per gram (pCi/g) for the inner concentric circle and 0.01 to 1.94 pCi/g for the outer concentric circle. Values for sites 1-090 (2.52 ± 0.27 pCi/g), 1-108 (8.56 ± 0.81 pCi/g), 1-126 (1.08 ± 0.13 pCi/g) and 2-090 (1.94 ± 0.23 pCi/g) located east of the main facilities area exceeded the State of Colorado standard of 2.0 dpm/g (0.9 pCi/g). Contamination at these sites originated from the 903 Pad.

External Gamma Radiation Dose Monitoring

Thermoluminescent dosimeters (TLDs) were used to measure external penetrating gamma radiation exposure at 46 locations on and off RFP. Average annual dose equivalents measured onsite, in perimeter environs, and in nearby communities were 167, 138, and 159 mrem, respectively. These values are indicative of background gamma radiation in the area.

Assessment of Potential Plant Contribution to Public Radiation Dose

Potential radiation doses were calculated from ingestion, ground-plane, irradiation, and air-inhalation dose assessment source terms. The maximum radiation dose to an individual continuously present at the site boundary was 8.3×10^{1} mrem committed effective dose equivalent or 0.83% of the DOE interim standard for all pathways. Maximum community dose was 1.7×10^{2} mrem committed effective dose equivalent or 0.017% of the DOE interim standard for all pathways. Estimated dose commitment for all individuals to a distance of 80 km (50 mi) was below the DOE-recommended *de minimis* level of 1 mrem committed effective dose equivalent.

PREFACE

This report provides information to the public about the impact of the Rocky Flats Plant on the environment and public health. The report contains a compliance summary, description of environmental monitoring programs, and radiation dose estimates for the surrounding population for the period January 1 through December 31, 1989. General content and format for this report are specified by Department of Energy Order 5400.1.

An environmental surveillance program has been ongoing since the 1950s. Early programs focused on radiological impacts to the environment. The current program examines potential impacts to air, surface water, ground water, and soils from radiological and nonradiological sources.

Environmental operations at RFP are under the jurisdiction of several local, state, and federal agencies, most notably, the Colorado Department of Health, Environmental Protection Agency, and Department of Energy. A variety of reports are prepared at different intervals for these and other agencies in addition to the annual environmental report. A listing of these reports is given in Appendix A.

1.0 INTRODUCTION

D. B. COSTAIN

The Rocky Flats Plant (RFP) is part of a nationwide nuclear weapons research, development and production complex administered by the Rocky Flats Office of the U.S. Department of Energy. The primary mission of RFP is the fabrication of nuclear weapons components. Rockwell International was the prime operating contractor for RFP in 1989.

Rocky Flats Site Environment

RFP occupies an area of 2,650 hectares (ha) (6,550 acres) in northern Jefferson County, Colorado, approximately 26 kilometers (km) (16 mi) northwest of Denver (Figure 1). Main production facilities are located near the center of RFP within a fenced security area of 155 ha (384 acres). The remaining plant area contains limited support facilities and serves as a buffer zone to major production areas (US80a). [Note: Literature citations abbreviated within this report are alphabetically listed in the References section]

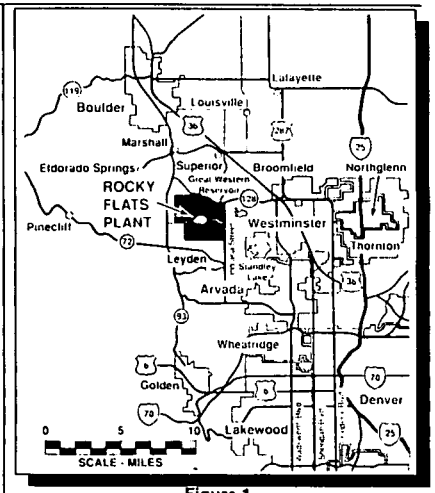

Figure 1
Area Map of Rocky Flats Plant and Surrounding Communities

Approximately 2 million people live within an 80-km (50-mi) radius of RFP. Adjacent land use is a mixture of agriculture, open space, industrial and low-density residential housing. Population distribution, based on 1980 census data and adjusted by yearly growth estimates, is shown in Figure 2 (DR89).

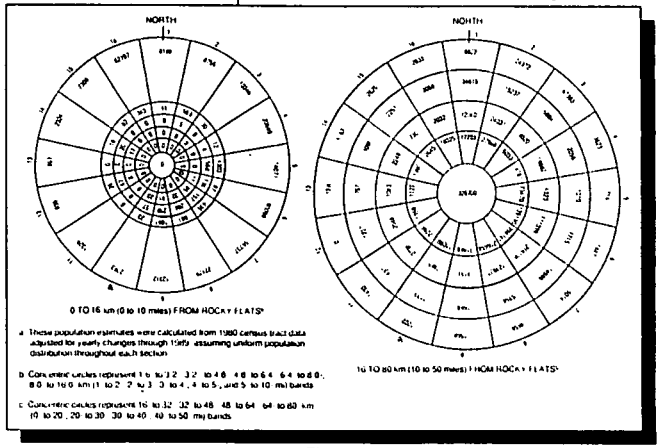

Figure 2
Demographic Estimates for Areas 0-10 and 10-50 Miles from the Rocky Flats Plant in 1989

Climate

Climate at RFP is characterized by dry, cool winters and warm summers. Elevation and major topographical features significantly influence climate and meteorological dispersion characteristics of the site. Winds, though variable, are predominately northwesterly. Annual precipitation averages slightly greater than 38.1 centimeters (cm) (15 in.) with more than 80% occuring between April

and September. Maximum and minimum temperatures average 23.3 degrees Celsius (°C) (76 degrees Fahrenheit [°F]) and -5.6°C (22°F), respectively (US80a). Meteorological and climatological information for 1989 are given in Appendix B.

Topography

RFP is situated at an elevation of about 1,830 meters (m) (6,000 feet [ft]) on the eastern edge of a geological bench known locally as Rocky Flats. This bench, about 8 km (5 mi) wide in an east-west direction, flanks the eastern edge of the abruptly rising foothills of the Front Range of the Rocky Mountains. To the east, topography slopes gradually at an average downgrade of 29 meters per kilometer (m/km) (95 ft per mi). Approximately 32 km (20 mi) to the west, the Continental Divide rises to elevations exceeding 4,270 m (14,000 ft).

Geology

RFP is situated on the Rocky Flats Elluvium, an alluvial fan deposit, varying in thickness from 0 to 30 m (0 to 100 ft) providing a gravelly cover over bedrock. Underlying bedrock formations consist primarily of claystone. Seismic activity of the area is low, and potentials for landslides and subsidence are not considered hazardous to RFP (US80a).

Hydrology

Surface drainage generally occurs in a west to east pattern along five ephemeral streams within RFP. North Walnut Creek, South Walnut Creek, and Woman Creek drain the main plant facilities area and supply water to two reservoirs used for municipal water supplies: Standley Lake and Great Western Reservoir.

Ground water systems at RFP consist of a shallow, unconfined system in the Rocky Flats Alluvium and a confined system in deeper sandstone units of underlying bedrock. Ground water flow generally is to the east within both systems. Hydrologic connection between the upper alluvium and lower bedrock occurs through sandstone units.

Rocky Flats Site Operations

Construction of RFP was approved by the U.S. Government in 1951 to increase production of nuclear weapons components. Limited operations began in 1952 within a total site area of 1,008 ha (2,520 acres) and a plant facilities area of less than 160 ha (400 acres). Early operations involved 63,000 square meters (m^2) (700,000 square feet [ft^2]) of building floor space in 20 structures. The U.S. Atomic Energy Commission (AEC) was the responsible government agency and Dow Chemical Company was prime contractor, responsible for operations. In 1974, the U.S. Energy Research and Development Administration (ERDA) succeeded AEC. ERDA was in turn succeeded by DOE in 1977. Within DOE, administrative responsibility was delegated to the Albuquerque Operations Office which established the Rocky Flats Area Office for day-to-day contact at RFP. In 1975, Dow Chemical Company was replaced by Rockwell International as the prime contractor. Rockwell International operated RFP through 1989.

Two major changes occurred in 1989 affecting administration and operation of RFP. First, the Rocky Flats Area Office was upgraded to the Rocky Flats Office, accountable directly to DOE headquarters in Washington, D.C. Secondly, DOE announced that Rockwell International was being replaced as prime contractor by EG&G Rocky Flats, Inc., effective January 1, 1990.

RFP fabricates nuclear weapons components from plutonium, uranium, beryllium, and stainless steel. Production activities include metal fabrication and assembly, chemical recovery and purification of process-produced transuranic radionuclides, and related quality control functions. Approximately 140 structures contain nearly 256,400 m^2 (2.76 million ft^2) of floor space. Of this space, major manufacturing, chemical processing, plutonium recovery, and waste treatment facilities occupy about 148,600 m^2 (1.6 million ft^2). Rockwell International employed 5,449 people at RFP in December 1989.

Radiation at the Rocky Flats Plant

RFP uses or handles both radioactive materials and radiation-producing equipment. Radiation-producing equipment includes X-ray machines and linear accelerators. Important radioactive materials include plutonium, americium, uranium, and tritium. These materials may be handled in sufficient quantities to pose an offsite hazard. The most important potential contributor to radiation dose from these materials is the alpha radiation emitted by the plutonium, americium, and uranium.

Because of the low penetrating ability of alpha radiation, these materials are primarily a potential internal radiation dose hazard. That is, the radioactive material must be taken into the body for the alpha radiation to be harmful. For this reason, environmental protection at RFP focuses on minimizing release of radioactive materials to the environment. Environmental monitoring focuses on pathways by which the materials could enter the body such as air inhalation and water ingestion. A pathway is a potential route for exposure to radioactive or hazardous materials.

Appendix C, "Perspective on Radiation," describes the basic concepts of radiation. Readers unfamiliar with the types and sources of ionizing radiation are encouraged to read this section for a better understanding of environmental monitoring data and radiation dose assessment at RFP. A more detailed assessment of radiation dose to the public from RFP is presented in Section 3.6, "Assessment of Potential Plant Contribution to Public Radiation Dose."

COMPLIANCE SUMMARY

2.0

G. V. PORTER

Monitoring data are obtained from routine sampling to measure environmental impacts resulting from activities at RFP. Results from this monitoring are reported to local, state and federal agencies including the EPA, DOE, and CDH who are responsible for enforcing environmental regulations at RFP. These agencies oversee compliance with applicable standards, issue permits, participate in joint monitoring programs, and inspect facilities. Table 2.0-1 lists current environmental permits and permit applications for RFP.

National Environmental Policy Act (NEPA)

NEPA is the nation's most comprehensive legislative and public policy statement on the protection of the environment. Federal regulations administered by the Council on Environmental Quality require submittal of NEPA documentation to

TABLE 2.0-1

Environmental Permits and Permit Applications for the Rocky Flats Plant in 1989

Permit/ Application	Number	Medium	Issuing Agency	Status
NPDES (12/26/84)	CO-0001333	Water	EPA	Application for Revision Pending
Bldg. 122 Incinerator (3/25/82)	C-12,931	Air	State of Colorado	Active Permit
Bldg. 771 Incinerator (8/28/85)	12JE932	Air	State of Colorado	Active Permit (Inactive Source)
Bldg. 776 Incinerator (3/25/82)	C-13,022	Air	State of Colorado	Active Permit (Inactive Source)
Bldg. 123	86JE018	Air	State of Colorado	Active Permit
Fugitive Dust Renewed (12/28/89)	87JE084L	Air	State of Colorado	Active Permit
RCRA Part A	CO-7890010526	Hazardous, Low-level Mixed and Transuranic Mixed Waste	CDH	Interim Status Confirmed August 1989
RCRA Part B	---------	Hazardous and Low-level Mixed Waste	CDH	Application for Permit Pending
RCRA Part B	---------	Transuranic Mixed Waste	CDH	Application for Permit Pending

evaluate major federal actions significantly affecting the quality of the human environment. NEPA documentation includes the Environmental Assessment (EA) and Environmental Impact Statement (EIS).

RFP established a NEPA Compliance Committee (NCC) in February of 1989 to provide an integrated review, guidance and oversight for plantwide activities. The NCC created a Rocky Flats Plant Environmental Checklist (EC) that is required for all proposed actions. The EC provides an initial screening and review of construction and engineering projects to determine if submission of an Action Description Memorandum (ADM) is required. ADMs are submitted to DOE for a determination of the level of NEPA documentation required.

Draft EAs for the Interim Remedial Action at the 881 Hillside area (DOE/EA-0413) and Supercompactor and Repackaging Facility and Tru Waste Shredder (DOE/EA-0432) were submitted to DOE for review and approval in 1989. Responses from the Office of NEPA Project Assistance were expected in early 1990. An EA or EIS will be prepared prior to remediation of the 903 Pad, Mound, and East Trenches areas once the extent of remediation is determined. No draft or final EIS was issued by RFP during 1989.

Clean Air Act

The Clean Air Act sets standards for ambient air quality and hazardous air pollutants. At RFP the focus is upon radioactive and nonradioactive hazardous emissions (Section 3.1, "Air Monitoring"). Emissions permits for RFP are listed in Table 2.0-1.

National Emission Standards for Hazardous Air Pollutants (NESHAP)

NESHAP govern both radioactive and nonradioactive pollutants and are administered by EPA and the State of Colorado, respectively. Under regulations promulgated in 1985, NESHAP limited airborne radionuclide emissions from DOE facilities to levels which would result in radiation doses no higher than 25 mrem per year total body dose equivalents and 75 mrem per year organ dose equivalent. Compliance is determined by calculating the highest effective dose equivalent to any member of the public at any offsite point where there is a residence, school, business or office.

RFP submitted the "Air Compliance Report" and dose calculations for the previous calendar year to EPA in 1989. Section 3.6, "Assessment of Potential Plant Contribution to Public Radiation Dose," includes a discussion of these results. Radiation dose from radionuclide emissions were within NESHAP limits. EPA modified radionuclide emission standards on December 15, 1989, effective for 1990. New standards limit effective dose equivalent to 10 millirem per year (mrem/yr) to any member of the public in any year.

Colorado Air Quality Control Regulation #8

Regulation #8 implements NESHAP for nonradioactive pollutants in Colorado. This regulation specifies work standards, emission limitations and ambient air standards for hazardous air pollutants including asbestos, beryllium, mercury, benzene, vinyl chloride, lead, and hydrogen sulfide. Potential hazardous air pollutants at RFP include asbestos and beryllium. Asbestos was used as insulation in the older facilities and is handled according to NESHAP regulations during demolition, renovation, or disposal. Beryllium is machined at RFP. The emissions standard is 10 g of beryllium over a 24-hr period. Beryllium emissions from RFP did not exceed this standard in 1989 (Section 3.1, "Air Monitoring").

The Special Assignment Team (Section 3.0, "Environmental Monitoring Programs") found that beryllium emissions were monitored on a monthly basis, whereas EPA methods required sampling to determine maximum releases in a 24-hr period. Although total beryllium emissions for 1989 were below the daily emissions limit, RFP will conduct compliance testing on five air ducts in 1990, which have the highest potential beryllium emissions. This testing will measure beryllium emissions for 24-hr periods and will serve as the basis of an application for waiver of emission testing and daily sampling requirements.

Colorado Air Quality Control Regulation #3

Regulation #3 implements information gathering and permitting processes of air pollution control requirements listed under Code of Colorado Regulations, Title 5 - Department of Health, Chapter 1001, Air Quality Control Commission Regulations, Article 2-13, 15, and 16. The Air Pollution Emission Notice (APEN) form is the mechanism which allows CDH to track air pollution sources, determine their impacts, and issue appropriate air emissions permits. APENs are required for most sources emitting "air pollutants" as defined in the Common Provisions of the Air Quality Control Regulations. RFP began a new plantwide air emissions survey in 1989 as an initiative of the Agreement in Principle. The survey will continue through 1990, and results will be submitted on APEN forms to the Air Quality Control Division of CDH. New APEN submittals are ongoing, with the following new or revised APENs being addressed in 1989:

Site	Description
Building 771	Incinerator
Building 776	Incinerator
Building 121	Incinerator
Building 444-DO5	Machine shop
Building 444-MAI	Process, machinery and foundry hoods
Building 447-MAI	Chip roaster, hood and room air
Building 778-LDY	Laundry
Building 865-EEE	Research and development machine shop and room air
Building 865-WWW	Hoods and machine shop
Building 123	Urinalysis laboratory
Building 443	Steam plant boilers, #4, #5, #6, #7
General	A collective APEN representing 44 potential beryllium emission points
Offsite	Overlot grading and associated construction activities

Clean Water Act

The Clean Water Act sets national effluent limitations and water quality standards and establishes a regulatory program to ensure enforcement. In Colorado, discharge permits for federal facilities, such as RFP, are issued by EPA. The State of Colorado sets water quality standards for receiving streams and bodies of water.

National Pollutant Discharge Elimination System (NPDES)

NPDES requires a permit before any pollutant is discharged into the waters of the United States. The permit must incorporate Best Management Practices (state-of-the-art technology) to prevent and control spills to the environment from hazardous and other pollutant sources. The current NPDES permit for RFP (No. CO-00013333) authorizes seven point-source discharge locations of which four, ponds A3, A4, B5 and C2, discharge into drainages leading off RFP. An application for renewal of this permit was filed in December 1988. The permit term expired and was administratively extended by EPA in June 1989 to allow preparation of a new permit. RFP did not violate NPDES limits in 1989 (Section 3.2, "Surface Water Monitoring").

Spill Prevention Control and Countermeasures/ Best Management Practices Plan (SPCC/BMP)

SPCC/BMP addresses facility improvements, operational procedures, policies, and requirements for reporting hazardous substances and oil spills to appropriate regulatory authorities and is administered by EPA. The SPCC/BMP for RFP was revised in 1989 to address changes associated with renewal of the NPDES permit.

Colorado Water Quality Control Commission (CWQCC) Temporary Water Standards

The CWQCC adopted temporary water quality standards in July 1989 for Walnut Creek and Woman Creek that require analysis for organic and inorganic chemicals, metals, radionuclides, and certain physical and biological parameters prior to discharge from final holding ponds at RFP. These standards were superceded in January 1990 by a modified list of parameters adopted as permanent standards. RFP provided samples to the State of Colorado for independent assessment of water quality before discharge, pursuant to the Agreement in Principle. Section 3.2, "Surface Water Monitoring," describes water quality standards in effect for 1989. RFP did not violate these temporary limits in 1989.

Compliance Events in 1989

Building 444 Chromic Acid Spill. Chromic acid, originating from a waste tank in a production area, breached secondary containment (berm and building floor) and leaked undetected to footing drains on February 22, 1989. Ground water contaminated by the acid was automatically pumped to the plant's sewage treatment facility where an estimated 4.3 kg (9.5 lb) was discharged to buffer zone Holding Pond B-3 and then onto spray irrigation fields. Runoff from these fields reached Pond B-5. Under normal circumstances this pond would have been discharged into the Great Western Reservoir, one of the raw water supplies for the city of Broomfield. However, the city of Broomfield requested a one-time diversion of the water via Upper Church Ditch to avoid municipal water supplies although water quality of Pond B-5 met EPA NPDES and Clean Water Act drinking water standards. Their request was granted and the diversion started on April 25 and ended on May 1, 1989. Requirements set by EPA specific to this diversion of surface drainage were met.

The estimated amount of chromium did not exceed the RCRA reportable quantity of 450 kg (1,000 lb). Also, discharge from Pond B-5 did not exceed the applicable water quality standard for chromium of 0.05 parts per million (ppm). The Rocky Flats Office of DOE notified the State of Colorado and EPA officials of this unplanned release. Corrective actions included, but were not limited to, installing a liner in the secondary containment area under the waste tanks, renovating the control system, upgrading the waste tank alarm system, and installing a recycle pump for waste tank sampling.

Atrazine in Surface Water Ponds. On July 6, 1989, EPA notified RFP that Atrazine had been found at levels of 18-20 parts per billion (ppb) in Ponds A-4, B-5 and C-2. Subsequent sampling on July 30, 1989, revealed levels of 5-46 ppb. Atrazine is a state-approved herbicide historically applied at RFP by a licensed contractor in conformance with the Federal Insecticide, Fungicide and Rodenticide Act. Atrazine is not a RCRA-listed compound and was not limited under temporary Colorado Water Quality Control Commission Classifications and Standards adopted on July 11, 1989. However, Atrazine is listed in the "Proposed National Primary Drinking Water Regulations" with a limit of 3 ppb. It is antici-

pated these regulations will be adopted by the EPA in December 1990. CDH recommended that RFP adhere to proposed federal limitations for Atrazine.

Granular activated carbon adsorption treatment was used to remove Atrazine from Pond A-4 and Pond B-5 water. Four systems (500 gallons per minute [gpm] each) cycle-treated the pond water without discharge until samples of treated water were approved by CDH. Ponds A-4 and B-5 were discharged into Walnut Creek from August 24, 1989, through October 17, 1989, and from August 17, 1989, through October 1, 1989, respectively. CDH decided carbon treatment was not necessary for Pond C-2. However, elevated levels of magnesium and sulfites were observed in pre-discharge samples. Appropriate treatment was determined to be spray aeration of the water for 2 weeks prior to discharge to Woman Creek. This was completed and Pond C-2 was discharged from October 4, 1989, to October 20, 1989.

Toxic Substances Control Act (TSCA)

TSCA authorizes testing and regulation of chemical substances entering the environment. TSCA supplements sections of the Clean Air Act, the Clean Water Act, and the Occupational Safety and Health Act and is administered by EPA. Compliance with TSCA at RFP is directed at management of polychlorinated biphenyls (PCBs) and asbestos.

In 1989, RFP completed replacement of 25 transformers and 300 capacitors containing PCB-contaminated oils with transformers and capacitors that did not contain PCBs. Nonradioactive PCBs were shipped to certified waste disposal sites. No disposal sites presently exist for radioactive PCBs. Consequently, these wastes are being stored temporarily until an acceptable waste disposal method or facility is identified.

Nonradioactive asbestos waste is disposed of in a designated pit at RFP. Radioactive asbestos waste is being temporarily stored until disposal at the Nevada Test Site becomes available.

Resource Conservation and Recovery Act (RCRA)

RCRA provides "cradle-to-grave" control of hazardous waste by imposing management requirements on generators and transporters of hazardous wastes and upon owners and operators of treatment, storage, and disposal facilities. The State of Colorado, under authority of EPA, regulates hazardous and radioactive mixed-wastes at RFP. Solely radioactive wastes are regulated by the Atomic Energy Act of 1954 as administered through DOE orders.

Part A and Part B Permits

The RCRA Part A permit application identifies facility location and operator, hazardous and mixed wastes to be managed and hazardous waste management methods. A facility that has submitted a RCRA Part A permit application is allowed to manage hazardous wastes under transitional regulations known as the interim status requirements pending issuance of a RCRA Operating Permit. The RCRA Part B permit application consists of a detailed narrative description of all facilities and procedures related to hazardous waste management.

RCRA Part A and Part B permit applications for RFP cover hazardous waste treatment and storage operations. RFP does not practice hazardous waste disposal. As the result of Settlement Agreement and Compliance Order #89-07-10-01 among CDH, DOE, and Rockwell International, a consolidated RCRA Part A permit application was submitted to CDH in August 1989 which included all hazardous, low-level mixed and transuranic mixed wastes. Separate RCRA part B permit applications were submitted previously for hazardous/low-level mixed waste (December 1989) and transuranic mixed waste (July 1988).

The public comment period on the draft RCRA Part B permit for hazardous and low-level mixed waste opened on October 4, 1989, and a public meeting was held on November 14, 1989. CDH has prepared a draft RCRA permit for 9 of 20 hazardous and low-level mixed waste units at RFP and a Notice of Intent to Deny (NOID) for the remaining 11 units. CDH cited the inability of CDH personnel, who lacked appropriate security clearances, to inspect units in production areas and inaccuracies in the permit application as reasons for the NOID. RFP submitted comments on the draft RCRA permit on December 18, 1989. Following a meeting with CDH and subsequent letter from DOE, the public comment period was extended to March 30, 1990, to allow RFP to submit additional information for waste units addressed in the NOID. The application for transuranic mixed waste is under review by CDH.

RCRA Closure Plans

RCRA closure plans identify procedures removing hazardous waste management units from service and programs to prevent both short- and long-term threats to human health and the environment. These plans describe initial measures to minimize maintenance of hazardous waste management units, to control and limit release of hazardous constituents and a plan to close units with monitoring during the post-closure period.

Hazardous waste management facilities which operate under interim status (40 CFR 265) and facilities which will operate under a permit (40 CFR 264) must be addressed in RCRA Closure Plans (40 CFR, Parts 264 and 265, Subpart G). Closure plans for facilities which begin or continue operation

following the interim status period must be addressed in the RCRA Part B permit. Hazardous waste management facilities that discontinue operation during the interim status period must be addressed by a separate RCRA Part B post-closure permit that specifically covers post-closure for interim status units. These are units that have been removed from service but require post-closure monitoring and maintenance.

RFP has submitted closure plans in RCRA Part B permit applications for all currently operating hazardous waste management facilities. Closure plans also have been submitted for facilities which have ceased operations during the interim status period (i.e., through December 31, 1989). These interim status plans are listed in Table 2.0-2. Included in this table are eight closure plans submitted in 1989 for outdoor storage pads (two plans), internal building areas (five plans) and storage tanks (one plan). All closure plans are under review by EPA and CDH.

RFP continued characterization and monitoring of interim status closure units in 1989. Efforts were focused on priority areas, specifically, the Solar Ponds, Present Landfill, West Spray Field and the Original Process Waste Lines areas. Major activities included removal of waste inventory, ground water, and surface water monitoring, soil sampling, and installation of new ground water monitoring wells. Annual ground water monitoring reports for these high-priority areas were submitted to CDH and EPA on March 1, 1989, and March 1, 1990 (RI89a, EG90a). These reports summarized ground water activities, data, and the rate and extent of contaminant migration for 1988 and 1989.

The draft Interagency Agreement modifies the development and implementation of interim status closure plans at RFP. For purposes of study and cleanup, all areas subject to interim status closure plans are combined under a single designation, Operable Unit No. 3. Closure plans must be redrafted into the format of a RCRA Facilities Investigation/Remedial Investigation work plan. Phase I investigations will characterize soils and waste sources, and Phase II will investigate ground water. Both phases must be completed to fully evaluate and plan all potential remedial actions.

RCRA Contingency Plan

The RCRA Contingency Plan (Section G of the RCRA Part B permit) is designed to minimize hazards to human health or the environment from fires, explosions, or unplanned sudden or non-sudden release of hazardous waste or hazardous waste constituents to air, soil, or surface water. RFP reports releases if:

1) a minimum of 1 lb of solid or 1 pt of liquid hazardous or mixed wastes is released to the environment;
2) a release inside a building exceeds the reportable quantity according to 40 CFR 302;
3) a release is considered a hazardous waste incident using the RCRA definition of hazardous waste; and
4) a release requires more than first aid treatment, provided it occurs in a hazardous waste management unit.

In 1989, 23 RCRA Contingency Plan Implementation Reports were filed with CDH for RFP.

Compliance Events in 1989

Compliance Order #89-06-07-01. In June 1989, RFP received Compliance Order #89-06-07-01 from CDH citing 25 alleged violations of the Colorado Hazardous Waste Act. Alleged violations pertaining to environmental monitoring included inadequate ground water monitoring and quality assessment. RFP responded to items contained in the Compliance Order on July 24, 1989, and agreed to certain actions designed to resolve concerns raised by CDH including development of a ground water assessment plan. RFP submitted the ground water assessment plan in September 1989.

Settlement Agreement and Compliance Order #89-07-10-01. In July 1989, Settlement Agreement and Compliance Order #89-07-10-01 was reached, resolving a number of issues regarding storage of low-level and transuranic mixed wastes at RFP. The agreement established a limit of 1,601 cubic yards (yd^3) of transuranic mixed waste storage on plant site.

Federal Facilities Compliance Agreement and Compliance Order on Consent #RCRA (3008) VIII-89-25. In September 1989, DOE, CDH, and EPA signed a Federal Facilities Compliance Agreement and Compliance Order on Consent that provides a 1-yr period for DOE to work toward compliance with "land disposal restrictions" of the Hazardous and Solid Waste Amendments of 1984. During this period, DOE must take steps to address and resolve alleged land disposal violations at RFP including, at a minimum, actions to assure accurate identification, safe storage, identification of treatment methodologies and minimization of wastes prohibited from land disposal. RFP submitted the following documents to EPA in compliance with this agreement: "Storage Report" (October 19, 1989); "Inventory Report" (November 18, 1989); "Waste Minimization Report" (December 18, 1989); and "Treatment Plan No.1" (December 28, 1989).

Settlement Agreement and Compliance Order on Consent #89-10-30-01. In November 1989, DOE, CDH and EPA signed Settlement Agreement and Compliance Order on Consent #89-10-30-01 regarding alleged violations of RCRA hazardous waste regulations for failure to implement proper waste management procedures for "onsite process residues." During 1990, this agreement requires DOE to submit plans for residue classification, residue characterization, and RCRA compliance. RFP submitted the following documents in 1989 to CDH in compliance with this agreement: "Inventory Report" (December 15, 1989) and "Draft Compliance Framework Report" (December 15, 1989).

TABLE 2.0-2

RCRA Interim Status Closure Plans for the Rocky Flats Plant

Plan	Date of Initial Submittal	Date of Additional Submittance
Solar Evaporation Ponds	11/28/86[a]	3/1/87; 7/1/88
Present Landfill	11/28/86	7/1/88
West Spray Field	11/28/86	10/3/88
Original Process Waste Lines	11/28/86	10/3/88
Container Storage Facility	11/28/86	4/5/88
Building 443 #4 Fuel Oil Tank	11/28/88	4/5/88
Main Hazardous Waste Storage	6/30/88[b]	
Original Uranium Chip Roaster	10/3/88	
Building 444 Acid Dumpsters	10/3/88	
Bench Scale Treatment Unit #32	10/3/88	
Building 460 Acid Dumpsters and Solvent Dumpsters	10/3/88	
SWMU #53, Bldg. 371 and 771 Treatment and Storage Facilities	4/1/89	
SWMU #60, Bldg. 371, Room 1208 Storage Facility	4/1/89	
SWMU #16, Bldg. 980 Cargo Container	9/89	
SWMU #26, Bldg. 881 Drum Storage	9/89	
SWMU #63, Bldg. 371 Drum Storage	9/89	
Tanks T-40, T-66, T-67, and T-68, SWMU #55	9/29/89	
SWMU #15, Storage Pad 904	9/30/89	
SWMU #25, Storage Pad 750	9/30/89	

a. Draft interim status closure plan submitted to regulatory authorities on August 29, 1986. This plan was for review and comment prior to final submision of an interim status closure plan.

b. This plan was completed on June 30, 1988, but was not submitted to the CDH/EPA until July 5, 1988.

Waste Minimization. The Rocky Flats Plant Waste Minimization Program realized an 80% reduction in the use of 1,1,1-trichlorethane (TCA) and Freon-113 between early 1988 and the end of 1989. A major goal of this program is elimination of hazardous solvents used for cleaning, namely TCA, Freon-113 and carbon tetrachloride. A waste paper recycle program was initiated in April 1988, and 51.4 tons were recycled that year. An increase in recycled paper was achieved in 1989 to 116.7 tons of paper and 60 tons of cardboard.

The status of these and other waste minimization projects was given in the Waste Minimization Assessment submitted to the CDH on December 18, 1989. The assessment meets requirements of both the Agreement in Principle and the Federal Facilities Compliance Agreement and Compliance Order on Consent.

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

CERCLA and major amendments (Superfund Amendment and Reauthorization Act [SARA]) provide funding and enforcement authority for restoration of hazardous waste sites and for responding to hazardous substance spills. Sites contaminated by past waste activities must be investigated and remediation plans developed and implemented. The intent of these actions is to minimize the release of hazardous waste or other hazardous materials, thereby protecting human health and the environment.

CERCLA requirements are addressed in a series of sequential phases designed to identify, design and complete restoration of contaminated sites. In 1989 and early 1990, RFP submitted several reports and work plans to CDH and EPA which reflect phased implementation of CERCLA activities, begun in 1987, at the 881 Hillside and 903 Pad, Mound, and East Trenches Areas. Those reports were as follows:

- "Background Hydrogeochemical Characterization & Monitoring Plan," January 1989 (RI89b);
- "Proposed Interim Measures/Interim Remedial Action Plan and Decision Document, 903 Pad, Mound, and East Trenches Area," December 1989 (RI89c);
- "Draft Phase II RI/FS Work Plan, Rocky Flats Plant, 903 Pad, Mound and East Trenches Areas, Operable Unit No. 2," December 1989 (RI89d);
- "Background Geochemical Characterization Report," December 1989 (RI89e);
- "Interim Remedial Action Plan for 881 Hillside Area," August 1989 (RI89f); and
- "Draft Phase III RI/FS Work Plan, Rocky Flats Plant, 881 Hillside Area Operable Unit No.1," January 1990 (RI90).

The 881 Hillside area was designated Operable Unit #1 (O.U.1) and the 903 Pad, Mound, and East Trenches areas as Operable Unit #2 (O.U.2) pursuant to the Interagency Agreement. The Interim Remedial Action Plan cited above described proposed actions to address contaminated alluvial ground water at O.U.1. The public comment period for this plan opened October 12, 1989, and closed November 27, 1989. Public meetings were held on October 24 and November 9, 1989. Interim remedial construction at the 881 Hillside began in January 1990.

Compliance Events in 1989

RFP was added to the National Priorities List (NPL) on October 4, 1989. NPL is an ordered ranking of CERCLA sites evaluated using the Hazardous Ranking System. If a site scores above a certain threshold level set by EPA, the site is placed on the NPL. RFP had been proposed for inclusion on the NPL for a number of years and had been studied by EPA to determine whether the site met criteria for NPL listing.

Emergency Planning and Community Right-to-Know Act (EPCRA)

EPCRA was enacted as a free-standing provision of SARA in 1986. This statute requires facilities to notify state and local emergency planning entities of the presence of potentially hazardous substances in their facilities and to report on the inventories and environmental releases of those substances. The intent of these requirements is to provide the public with information on hazardous chemicals in their communities, enhancing public awareness of chemical hazards and facilitating development of state and local emergency response plans.

Section 312

Section 312 of EPCRA requires facilities to prepare an annual report titled, "Tier II Emergency and Hazardous Chemical Inventory Forms," listing the quantities and locations of hazardous chemicals. The report must be submitted to local emergency planning and response authorities. RFP submitted this report to the following agencies in 1989: Colorado Emergency Planning Commission, Jefferson County Emergency Planning Committee, Boulder County Emergency Planning Committee, and the Rocky Flats Fire Department (jurisdictional fire department).

Section 313

Section 313 of EPCRA requires facilities to prepare an annual report titled "Toxic Chemical Release Inventory,

Form R," if threshold quantities of listed toxic chemicals are exceeded. In 1989, threshold chemical quantities were:

- 25,000 lbs for listed chemicals either manufactured or processed; and
- 10,000 lbs for listed chemicals otherwise used.

Facilities must report quantities of both routine and accidental releases of listed chemicals, maximum amount of the listed chemical stored onsite during the calendar year and amount contained in wastes transferred off-site. RFP submitted this report to EPA in 1989 detailing the following chemicals used in 1988:

Chemical	Annual Use (lbs)
Carbon Tetrachloride	186,816
Freon-113	36,893
Hydrogen Fluoride	64,159
Nitric Acid	436,711
Phosphoric Acid	12,059
Sodium Hydroxide Solution	536,535
Sulfuric Acid	13,174
1,1,1-Trichloroethane	47,630

Interagency Agreement

A draft Interagency Agreement was negotiated among EPA, CDH, and DOE during 1989 to serve as the framework for environmental restoration activities at RFP. This agreement clarifies EPA, CDH and DOE regulatory roles, coordinates oversight efforts, and corrective actions, standardizes requirements, and ensures compliance with orders and permits. The Interagency Agreement also specifies delivery of major reports, project management activities, and milestones, including community involvement and decision making responsibilities. The draft agreement divides RFP into ten operable units for characterization and cleanup. Groupings are based on location or similarity of site characteristics. A draft of this agreement was made available for public review and comment beginning December 22, 1989. The public comment period ended on February 21, 1990.

Agreement in Principle

An Agreement in Principle was executed between DOE and the State of Colorado on June 28, 1989. This agreement identifies additional technical and financial support by DOE to Colorado for environmental oversight, monitoring, remediation, emergency response, and health-related initiatives associated with RFP. Also, the agreement addresses RFP environmental monitoring initiatives and accelerated cleanup where contamination may present an imminent threat to health or the environment. The agreement is designed to assure citizens of Colorado that public health, safety and the environment are being protected through accelerated existing programs and substantial new commitments by DOE, and through a vigorous program of independent monitoring and oversight by Colorado officials.

Settlement Agreement (Church vs. DOE et al.)

A settlement agreement among DOE, Dow Chemical Company, Rockwell International, local governments, and private landowners was reached in July 1985, requiring remediation actions to reduce plutonium contamination on areas adjacent to the eastern boundary of RFP. Contamination originated from the area now designated as the 903 Pad and occurred through airborne dispersion of plutonium particles. Soils analyses revealed offsite plutonium levels exceeding the Colorado standard of 2 disintegrations per minute per gram (dpm/g) (0.9 pCi/g), though the EPA screening level of 44.4 dpm/g (20.0 pCi/g) was not exceeded. Court-ordered remedial action was designated for 350 acres through plowing and revegetation to prevent resuspension of the plutonium. Legal ownership of these contaminated lands was transferred to Jefferson County and the City of Broomfield for reservoir expansion and open space (no public access is permitted).

Approximately 120 acres of Jefferson County land have been treated by plowing, tillage and seeding. Plutonium levels for these areas are now within state limits. However, revegetation measures have been largely unsuccessful. Remediation activities planned for 1990 include further tillage and seeding with irrigation.

3.0 ENVIRONMENTAL MONITORING PROGRAMS

D. B. COSTAIN

Overview

The objective of environmental management at RFP has been to minimize and, where practical, eliminate the discharge of radioactive and nonradioactive hazardous effluents. Performance of this objective has been measured by monitoring programs designed to quantify potential impacts to the public and the environment. Effective with the change in the prime contractor to EG&G Rocky Flats, Inc. (January 1, 1990), all environmental programs were consolidated under the Director of Environmental Restoration (ER). Objectives were expanded under ER to include restoring and enhancing the environment in and around RFP.

RFP conducts operations that involve or produce liquids, solids, and gases containing both radioactive and nonradioactive but potentially hazardous materials. RFP environmental programs monitor penetrating ionizing radiation and pertinent radioactive, chemical, and biological pollutants. Data on air, surface water, drinking water, ground water, and soils provide information to assess immediate and long-term environmental consequences of normal and unplanned effluent discharges and actual or potential exposures to critical populations. Site-specific data are used to evaluate risk to humans and to assist warning of unusual or unforeseen conditions, when special environmental monitoring programs might be activated. Routine reports to local, state, and federal agencies and the public provide information on the performance of these programs in maintaining and improving environmental quality and public health and safety at RFP. The document, "Catalogue of Monitoring Activities at Rocky Flats" (RI89g), together with ground water reports (RI89a, RI89d, RI90), describe environmental monitoring programs at RFP. Each of the following sections also presents an overview of monitoring activities for 1989. Table 3.0-1 lists the primary environmental compliance standards for environmental monitoring programs at RFP.

In addition to environmental programs performed by EG&G Rocky Flats, Inc., several federal, state, and local governmental agencies conduct independent audits and environmental surveys within and adjacent to RFP. CDH, DOE, and the cities of Broomfield and Westminster conduct various air, water and soils monitoring programs. Data are reported collectively at monthly Environmental Monitoring Information Exchange Meetings. RFP provides monthly environmental monitoring summaries at these meetings which are open to the public and have been ongoing since the early 1970s.

The Honorable Roy Romer, Governor of Colorado, created a Governor's Rocky Flats Scientific Advisory Panel on Monitoring Systems on July 7, 1989. Objectives of this panel were: 1) to determine whether current and proposed monitoring systems were adequate to detect release, distribution, and concentrations of materials in amounts recognized as hazardous to human health; 2) to determine whether the information had been collected in a condition suitable for analysis, modeling, and interpretation; and 3) to recommend corrections as necessary. A final report on recommendations by the panel was scheduled for March 1990.

Sections 3.1-3.6 of this report summarize results of environmental monitoring programs at RFP in 1989. Results are commonly compared to appropriate guides and standards which establish limits for radioactive and nonradioactive effluents. Readers unfamiliar with these standards are encouraged to review Appendix D, "Applicable Guides and Standards."

Special Assignment Team

On June 6, 1989, DOE mobilized a Special Assignment Team to provide an independent evaluation of operations and practices at RFP. This followed initiation of a search warrant by EPA based on an affidavit alleging regulatory and criminal

Table 3.0-1

Primary Compliance Standards for Environmental Monitoring Programs at the Rocky Flats Plant in 1989

Monitoring Program	Compliance Standards
AIR	
Effluent Air	NESHAP (Title 40 CFR 61)[a]
	Colorado Air Quality Control Regulation #8 (Title 5 CCR 1001)
	General Environmental Protection Program (DOE Order 5400.1)
	Environmental, Safety, and Health Program for Department of Energy Operations (DOE Order 5480.1B)
Nonradioactive Ambient Air	NAAQS (Title 40 CFR 50)[b]
	General Environmental Protection Program (DOE Order 5400.1)
	Environmental, Safety, and Health Program for Department of Energy Operations (DOE Order 5480.1B)
Radioactive Ambient Air	General Environmental Protection Program (DOE Order 5400.1)
	Environmental, Safety, and Health Program for Department of Energy Operations (DOE Order 5480.1B)
SURFACE WATER	
Surface Water	NPDES[c] (Title 40 CFR 122, 125)
	Colorado Water Quality Control Commission Temporary Surface Water Standards (Title 5 CCR 1000)
	General Environmental Protection Program (DOE Order 5400.1)
	Environmental, Safety, and Health Program for Department of Energy Operations (DOE Order 5480.1B)
Community Water	National Interim Primary Drinking Water Regulations (Title 40 CFR 141)
	Colorado Primary Drinking Water Regulations (Title 5 CCR 1002)
	General Environmental Protection Program (DOE Order 5400.1)
	Environmental, Safety, and Health Program for Department of Energy Operations (DOE Order 5480.1B)
GROUND WATER	CERCLA (Title 42 U.S.C. 9601)[d]
	RCRA (Title 42 U.S.C. 6901)[e]

Table 3.0-1 (Continued)

Primary Compliance Standards for Environmental Monitoring Programs at the Rocky Flats Plant in 1989

GROUND WATER	Colorado Hazardous Waste Management Act (Title 25 CRS, Article 15)
	General Environmental Protection Program (DOE Order 5400.1)
	Environmental, Safety, and Health Program for Department of Energy Operations (DOE Order 5480.1B)
SOILS	USAEC Rocky Flats Plant, 1973 Environmental Surveillance Summary Report[f]
	General Environmental Protection Program (DOE Order 5400.1)
	Environmental, Safety, and Health Program for Department of Energy Operations (DOE Order 5480.1B)
RADIATION DOSE	Radiation Standards for Protection of the Public in the Vicinity of DOE facilities[g]
	General Environmental Protection Program (DOE Order 5400.1)
	Environmental, Safety, and Health Program for Department of Energy Operations (DOE Order 5480.1B)

a. National Emission Standards for Hazardous Air Pollutants
b. National Ambient Air Quality Standards
c. National Pollution Discharge Elimination System
d. Comprehensive Environmental Response, Compensation and Liability Act
e. Resource Conservation and Recovery Act
f. USAEC Rocky Flats Plant, 1973 Environmental Surveillance Summary Report, CDH, Division of Occupational Health, 1973
g. DOE Memorandum from Environment, Safety and Health, W.A. Vaughan, Assistant Secretary, August 1985

violations of environmental law at RFP. The U. S. Department of Justice is conducting the investigation and a federal grand jury has been convened to review RFP compliance with applicable environmental laws.

The Special Assignment Team was divided into four groups, one of which was tasked with auditing environmental issues. Objectives of this Environmental Team were to determine: 1) whether any imminent threat existed to public health or the environment as a result of RFP activities; 2) whether RFP operations were being conducted in accordance with applicable environmental requirements and best management practices; and 3) the status of previously identified environmental problems.

Findings

The environmental audit was completed on July 21, 1989, and results were reported in the document, "Assessment of Environmental Conditions at the Rocky Flats Plant" (US89a). Major findings were as follows:

- No situations were observed which posed an imminent threat to public health or the environment;
- Implementation of environmental programs lacked coordination and was hindered by poor communication;
- Environmental programs required improvements to more accurately characterize and monitor plant-related emissions, discharges, and ambient conditions;

- Effective implementation of the site remediation program was adversely impacted by poor communication, coordination, planning, and scheduling;
- Implementation of an effective waste management program was severely hindered by site waste storage constraints, conservative waste classification practices, and a lack of options for treatment and final disposition of waste;
- The quality and reliability of sample collection, laboratory analyses, and other information generated in support of the environmental monitoring and restoration programs were not adequate to achieve program goals;
- Management and maintenance of the sewage treatment plant (STP) had received low priority resulting in inefficient operation which could create problems in meeting future permit requirements;
- The 1987 Waste Stream Characterization Study did not reflect current waste processes at RFP; and
- A comprehensive strategy was needed to perform activities required by NEPA.

Corrective Actions

EG&G Rocky Flats, Inc., responded to findings of the Special Assignment Team in the document, "EG&G's Response to the Assessment of Environmental Conditions at the Rocky Flats Plant" (EG90b). This response identified three major contributing causes for many of the findings: 1) lack of a single central environmental organization; 2) lack of funding to implement proposed changes to DOE orders and other environmental regulations in a timely manner; and 3) lack of an overall environmental management plan integrated in the plant overall management plan. The response by EG&G Rocky Flats, Inc., was presented as an Action Plan that included descriptions of measures to be taken by RFP to address findings and schedules, milestones, associated costs, and parties responsible for implementing planned actions. Many of the activities described in this Action Plan overlap or are similar to actions specified in the Agreement in Principle and Interagency Agreement described in Section 2.0, "Compliance Status" and to the RFP Five-Year Plan (FYP) for environmental and waste programs (RI89h).

Five-year and Site-Specific Plans

The purpose of the FYP is to establish an agenda for compliance and cleanup against which progress will be measured. The plan will be revised annually, with a five-year planning horizon. The FYP encompasses total program activities and costs for DOE Corrective Activities, Environmental Restoration, Waste Management and Applied Research and Development. Hazardous, radioactive, mixed (hazardous and radioactive), and sanitary wastes are addressed together with facilities and sites contaminated with or used in the management of those wastes. The FYP consists of Activity Data Sheets that describe activities at RFP and define budgets and schedules for these activities.

To describe how activities shown in the FYP would be implemented at RFP, a Site-Specific Plan (SSP) was prepared. Drafts of this plan were prepared in late 1989 and a final version in early 1990 (EG90c). The emphasis of the SSP is on near-term activities, primarily those to be accomplished in fiscal year 1990.

AIR MONITORING

3.1

M. R. BOSS, D. B. COSTAIN
AND R. J. CROCKER

Effluent Air Monitoring

Overview

Production and research buildings at RFP are equipped with ventilation exhaust systems. Particulates generated by production and research activities are captured by exhaust air stream air filters. These particulate materials are removed from the air stream in each exhaust system by means of High Efficiency Particulate Air (HEPA) filters. Residual particulates in each of these systems are continuously sampled downstream from the final stage of HEPA filters. For immediate detection of abnormal conditions, ventilation systems that service areas containing plutonium are equipped with Selective Alpha Air Monitors (SAAM). SAAMs are sensitive to specific alpha particle energies and are set to detect plutonium-239 and -240. These detectors are subjected to daily operational checks, monthly performance testing, and calibration for airflow, and an annual radioactive source calibration to maintain their sensitivity and reliability. Monitors alarm automatically if out-of-tolerance conditions are experienced. No such condition occurred during 1989.

At regular intervals, particulate samples from a continuous sampling system are removed from each exhaust system and radiometrically analyzed for long-lived alpha emitters. The concentration of long-lived alpha emitters is indicative of effluent quality and overall performance of the HEPA filtration systems. If the total long-lived alpha concentration for an effluent sample exceeds the RFP action guide value of 0.020×10^{-12} µCi/ml (7.4×10^{-4} Bq/m³), a follow-up investigation is conducted to determine the cause and to evaluate the need for corrective action. The action guide value is equal to the offsite Derived Concentration Guide (DCG) for plutonium activity in air. (See Appendix D for guide explanations.)

At the end of each month, individual samples from each exhaust system are composited into larger samples by location. An aliquot of each dissolved composite-sample is analyzed for beryllium particulates. The remainder of the dissolved sample is subjected to radiochemical separation and alpha spectral analysis that quantifies specific alpha-emitting radionuclides. Analyses for uranium isotopes are conducted for each composite sample.

Forty-two of the ventilation exhaust systems are located in buildings where plutonium processing is conducted. Particulate samples from these exhaust systems are analyzed for specific isotopes of plutonium and americium. Typically, americium contributes only a small fraction of the total alpha activity airborne release from RFP.

Processes ventilated from several exhaust systems potentially exhibit trace quantities of tritium contamination. Bubbler-type samplers are used to collect samples three times each week from the monitored locations. Tritium concentrations in the sample are measured using a liquid scintillation photospectrometer.

Results

Projected doses to the public from radionuclide emissions were within NESHAP limits (Appendix D, Table D-1). Section 3.6, "Assessment of Potential Plant Contribution to Public Radiation Dose," includes a discussion on radiation dose estimates from air emissions.

Plutonium and Uranium. During 1989, total quantities of plutonium and uranium discharged to the atmosphere from RFP processing and support buildings were 5.12 µCi (1.88×10^{5} Bq) and 7.62 µCi (2.82×10^{5} Bq), respectively (Tables 3.1-1 and 3.1-2). These values were corrected for background radiation.

The maximum plutonium and uranium sample concentrations were observed following a HEPA filter change on December 9 and 10 in Building 881. The sample concentration measured for plutonium was 0.145×10^{-12} µCi/ml (5.37×10^{-3} Bq/m³) and for uranium was 0.218×10^{-12} µCi/ml (8.07×10^{-3} Bq/m³).

The facility served by this exhaust system was originally constructed in 1956 and was designed for processing and machining enriched uranium. Over the years, production operations involving radioactive materials were phased-out or relocated to other, more suitable facilities. However, the

TABLE 3.1-1

Plutonium in Effluent Air at the Rocky Flats Plant in 1989

	Plutonium-239, -240			Plutonium-238		
Month	Number of Analyses	Total Discharge (μCi)	C_{max}[a] ($\times 10^{-12}$ μCi/ml)	Number of Analyses	Total Discharge (μCi)	C_{max}[a] ($\times 10^{-12}$ μCi/ml)
January	47	0.33	0.005 ± 0.0005	47	0.01	0.00007 ± 0.00001
February	47	0.15	0.001 ± 0.0001	47	0.00	0.00002 ± 0.00001
March	47	0.07	0.001 ± 0.0001	47	0.00	0.00002 ± 0.00001
April	47	0.28	0.001 ± 0.0001	47	0.01	0.00005 ± 0.00001
May	47	0.18	0.001 ± 0.0001	47	0.00	0.00002 ± 0.00001
June	47	0.06	0.001 ± 0.0001	47	0.01	0.00009 ± 0.00001
July	47	0.18	0.001 ± 0.0002	47	0.00	0.00003 ± 0.00003
August	47	0.07	0.001 ± 0.0002	47	0.00	0.00003 ± 0.00001
September	48	0.16	0.032 ± 0.0096	48	0.00	0.00054 ± 0.00021
October	47	0.05	0.000 ± 0.0000	47	0.00	0.00002 ± 0.00001
November	47	0.32	0.002 ± 0.0002	47	0.10	0.00075 ± 0.00007
December	48	3.03	0.145 ± 0.0060	48	0.06	0.00239 ± 0.00032
Overall	566	4.90[b]	0.145 ± 0.0060	566	0.22[b]	0.00239 ± 0.00032

a. Maximum sample concentration.
b. Minor discrepancies in total discharge values result from rounding errors in calculations.

TABLE 3.1-2

Uranium in Effluent Air at the Rocky Flats Plant in 1989

	Uranium-233, -234			Uranium-238		
Month	Number of Analyses	Total Discharge (μCi)	C_{max}[a] ($\times 10^{-12}$ μCi/ml)	Number of Analyses	Total Discharge (μCi)	C_{max}[a] ($\times 10^{-12}$ μCi/ml)
January	55	0.02	0.00009 ± 0.00007	55	0.13	0.00029 ± 0.00007
February	55	0.09	0.00113 ± 0.00017	55	0.12	0.00041 ± 0.00008
March	55	0.01	0.00154 ± 0.00018	55	0.03	0.00019 ± 0.00006
April	55	-0.02	0.00013 ± 0.00012	55	0.06	0.00056 ± 0.00009
May	55	-0.03	0.00022 ± 0.00007	55	0.00	0.00035 ± 0.00007
June	55	-0.02	0.00024 ± 0.00021	55	0.08	0.00005 ± 0.00008
July	55	0.01	0.00011 ± 0.00012	55	0.14	0.00052 ± 0.00012
August	55	0.17	0.00167 ± 0.00024	55	1.70	0.01324 ± 0.00147
September	56	-0.05	0.00146 ± 0.00290	56	0.08	0.02043 ± 0.00353
October	55	-0.01	0.00005 ± 0.00012	55	0.08	0.00023 ± 0.00010
November	55	0.07	0.00071 ± 0.00019	55	0.14	0.00006 ± 0.00009
December	56	4.77	0.21823 ± 0.00691	56	0.05	0.00015 ± 0.00008
Overall	662	5.02[b]	0.21823 ± 0.00691	662	2.60[b]	0.02043 ± 0.00353

a. Maximum sample concentration.
b. Minor discrepancies in total discharge values result from rounding errors in the calculations.

original ventilation ductwork containing residual contamination continued operation. Air was not recycled into the worker environment. Workspaces formerly devoted to uranium processing operations were decontaminated and are now occupied by research and development and non-destructive testing of nonradioactive materials.

A follow-up investigation of this occurrence suggested residual contamination was displaced and leaked past the HEPA filters during the filter change operations. The quantity of plutonium associated with this discharge was 2.95 μCi (1.09×10^5 Bq) and the quantity of uranium was 4.45 μCi (1.65×10^5 Bq). Effluent air samples collected following the period of the filter change until the system was shut down, were within the ranges typically measured from this exhaust system.

Approximately 125 filters were changed in the single-stage exhaust system. In-place testing of replaced HEPA filters revealed improper seals between the HEPA filters and mounting frames which created a leak path. This leakage was verified subsequently through laboratory analysis of smear samples from the down-flow side of the exhaust plenum. Upon discovering the leakage, the exhaust system was shut down until corrective repairs could be made. These repairs are scheduled for 1990 and will involve removing the filter plenum from service and redirecting the air stream to an alternate filter. The air dampers were closed and the return air ducts sealed off. Eighty occupants of the building were relocated and personnel movement to the affected areas was restricted. Procedural modifications were made to require additional contamination surveys immediately following changes in final stages of HEPA filters.

In September 1989, operation of RFP's primary plutonium recovery facility was suspended to accomplish upgrades to safety systems and to perform a general cleanup of the facility. A phased-in restart of the facility began in January 1990. The overall decreases in radionuclide emissions during 1989, compared to those of 1988, are a reflection of the reduced production activities for these facilities.

Values reported for total quantities of plutonium and uranium discharged for 1989 vary from the monthly environmental monitoring reports because of rounding in calculations and because the annual report includes plutonium-238, -239, and -240, whereas the monthly report gives plutonium-239 and -240. Plutonium-238 represented 4.5% of the total plutonium discharged in 1989.

Americium. Total americium discharged in 1989 was 1.18 μCi (Table 3.1-3). Maximum concentration was 0.033×10^{-12} μCi/ml, observed in samples taken in December. Americium values were corrected for background radiation.

TABLE 3.1-3

Americium in Effluent Air at the Rocky Flats Plant in 1989

	Americium-241		
Month	Number of Analyses	Total Discharge (μCi)	C_{max}[a] ($\times 10^{-12}$ μCi/ml)
January	47	0.03	0.00033 ± 0.00002
February	47	0.04	0.00010 ± 0.00002
March	47	0.07	0.00239 ± 0.00035
April	47	0.05	0.00017 ± 0.00004
May	47	0.04	0.00013 ± 0.00002
June	47	0.03	0.00007 ± 0.00001
July	47	0.04	0.00028 ± 0.00004
August	47	0.01	0.00008 ± 0.00002
September	48	0.00	0.00221 ± 0.00047
October	47	0.03	0.00040 ± 0.00005
November	47	0.14	0.00066 ± 0.00008
December	48	0.69	0.03314 ± 0.00459
Overall	566	1.18[b]	0.03314 ± 0.00459

a. Maximum sample concentration.
b. Minor discrepancies in total discharge value result from rounding errors in the calculations.

TABLE 3.1-4

Tritium in Effluent Air at the Rocky Flats Plant in 1989

Month	Tritium: Number of Analyses	Tritium: Total Discharge (Ci)	Tritium: C_{max}[a] ($\times 10^{-12}$ µCi/ml)
January	53	0.001	197 ± 145
February	54	0.002	166 ± 120
March	66	0.007	389 ± 220
April	65	0.152	14000 ± 320
May	64	0.003	65 ± 35
June	53	0.001	99 ± 10
July	73	0.001	108 ± 13
August	66	0.006	2735 ± 34
September	76	0.001	85 ± 10
October	84	0.001	64 ± 6
November	64	0.000	46 ± 7
December	40	0.000	24 ± 3
Overall	758	0.177[b]	14000 ± 320

a. Maximum sample concentration.
b. Minor discrepancies in total discharge value result from rounding errors in the calculations.

Tritium. Total tritium discharged in 1989 from ventilation systems in which tritium is routinely measured was 0.177 Ci (6.48×10^9 Bq) (Table 3.1-4). The maximum tritium concentration of 14000 x 10^{-12} µCi/ml (5.18×10^2 Bq/m³) was observed during April from routine operations in a plutonium production building. The quantity of tritium released during this sampling period was 0.071 Ci (2.63×10^9 Bq). Each month is divided into a series of individual sampling periods. The sum of discharge for these sampling periods is the total tritium discharge for the month. Tritium values include a small, unquantified contribution attributed to natural background (i.e., non-plant) sources.

Beryllium. Table 3.1-5 presents the beryllium airborne effluent data for 1989. Total quantity of beryllium discharged from ventilation exhaust systems was 4.94 g and the maximum concentration was 0.00157 µg/m³ observed in July. These values were not significantly above background levels associated with the analyses. The beryllium stationary-source emission standard is 10 g over a 24-hr period.

The total quantity of beryllium discharged from 1989 varies from the monthly environmental monitoring reports because the annual report includes values for all 50 exhaust systems, whereas the monthly report gave discharges for six exhaust systems on buildings where beryllium is processed. Beryllium discharges are monitored monthly at the remaining 44 locations but are only given in monthly reports if they exceed a screening level of 0.1 g.

RFP ceased using analytical blanks in laboratory analysis to correct sample beryllium concentrations in September 1989. Consequently, reported beryllium values measure both background concentrations and actual emission levels.

Nonradioactive Ambient Air Monitoring

Overview

Nonradioactive ambient air monitoring was conducted in 1989 for total suspended particulates (TSP) and respirable particulates (≤ 10 micrometers [µm]). Ambient air particulates are regulated by EPA and CDH under Clean Air Act Amendments of 1970 and 1977, as defined by the National Ambient Air Quality Standards (NAAQS) and Colorado Air Quality Control Commission Ambient Air Standards. Regulation is based on regional rather than site-specific air quality parameters. Formerly, EPA particulate standards (NAAQS) were based on TSP, a measure of total particulate recovery, regardless of particulate size. The present EPA standard, referred to as Particulate Matter-10 or PM-10, is based on respirable particulates, those particles less than or equal to 10 µm. Final EPA respirable particulate standards were issued July 1, 1987 (US87a), and reference methods were issued on October 6 and December 1, 1987. PM-10 samplers at RFP were procured to meet EPA design specifications.

Ambient air monitoring at RFP provides baseline information on particulate levels. Table 3.1-6 identifies sampling equipment used for measuring particulates. RFP monitors ambient air with both TSP and PM-10 samplers. Concurrent TSP sampling is conducted at the request of CDH until changes have been made in state regulations to reflect PM-10 changes in the federal regulations. TSP and PM-10 samplers are co-located near the east entrance to RFP. This location is unobscured by structures, near a traffic zone and generally downwind from plant buildings. Samplers are operated on an EPA sampling schedule of one day per every sixth day. TSP is measured by the EPA reference high-volume air sampling method.

Results

Particulate data are shown in Table 3.1-7, and current (PM-10) and former (TSP NAAQS) standards are given in Appendix D (Table D-2). Highest TSP value recorded in 1989 (24-hr sample) was 80 µg/m³ (31% of the former TSP 24-hr primary standard), and the annual geometric mean value was 53.5 µg/m³ (71% of former TSP primary annual geometric mean standard). The observed 24-hr maximum for the PM-10 sampler was 42.5 µg/m³ (28% of the Primary 24-hr Standard) and the annual arithmetic mean was 20.9 µg/m³ (42% of the Primary Annual Arithmetic Mean).

As part of an ongoing quality assurance program, particulate analyzers were subjected to an independent flow rate check on a quarterly basis. Observed flow rates were within ± 5% of the standard flow device and were within established EPA guidelines for ambient air particulate monitoring networks (± 15%).

Radioactive Ambient Air Monitoring

Overview

Radioactive ambient air samplers monitor airborne dispersion of radioactive materials from RFP into the surrounding environment. Samplers are designated in three categories by their proximity to the main facilities area. Onsite samplers (23) are located within RFP, concentrated near the main facilities area (Figure 3). Perimeter samplers (14) border RFP along major highways on the north (Highway 128), east

TABLE 3.1-5

Beryllium in Effluent Air at the Rocky Flats Plant in 1989

Month	Beryllium[a,b]: Number of Analyses	Beryllium[a,b]: Total Discharge[c] (g)	Beryllium[a,b]: C_{max}[d] (µg/m³)
January	55	0.154	0.00038
February	55	-0.221	0.00014
March	55	0.020	0.00019
April	55	0.021	0.00017
May	55	0.125	0.00043
June	55	0.371	0.00029
July	55	1.178	0.00157
August	55	1.073	0.00100
September	56	0.433	0.00110
October	55	0.599	0.00080
November	55	0.635	0.00071
December	56	0.548	0.00064
Overall	662	4.940	0.00157

a. The beryllium stationary-source emission-standard is no more than 10 grams of beryllium over a 24-hour period under the provisions of subpart C of 40 CFR 61.32(a).
b. Beginning in June, concentrations and emission values were not corrected for background contribution.
c. These values are not significantly different from the background associated with the analysis.
d. Maximum sample concentration.

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TABLE 3.1-6

Ambient Air Monitoring Detection Methods

Parameter	Detection Methods and Analyzer Ranges
PM-10 (Particulate Matter less than 10 micrometers in diameter.)	Wedding PM-10 Sampler
Total Suspended Particulates (TSP)	Reference Method (Hi Volume) 24-Hour sampling (6th-day scheduling)

TABLE 3.1-7

Ambient Air Quality Data for Nonradioactive Particulates at the Rocky Flats Plant in 1989

Total Suspended Particulates	µg/m³
Total Number of Samples, "A"[a]	62.0
Total Number of Samples, "B"[b]	61.0
Annual Geometric Mean, Sampler "A"	53.5
Annual Geometric Mean, Sampler "B"	51.7
Standard Deviation, Sampler "A"	17.9
Standard Deviation, Sampler "B"	22.1
Observed 24-Hour Maximum, "A"	78.9
Observed 24-Hour Maximum, "B"	80.1
Second Highest Maximum, "A"	70.2
Second Highest Maximum, "B"	74.9
Lowest Observed Value, "A"	16.5
Lowest Observed Value, "B"	12.2
Respirable Particulates (PM-10)	**µg/m³**
Total Number of Samples, "C"[c]	60.0
Total Number of Samples, "D"[d]	59.0
Annual Arithmetic Mean, "C"	20.9
Annual Arithmetic Mean, "D"	18.5
Observed 24-Hour Maximum, "C"	42.5
Observed 24-Hour Maximum, "D"	40.9
Second Highest Maximum, "C"	40.2
Second Highest Maximum, "D"	39.5

a. Primary ambient air TSP particulate sampler; reporting unit.
b. Co-located duplicate TSP sampler.
c. Primary ambient air PM-10 sampler.
d. Co-located duplicate PM-10 sampler.

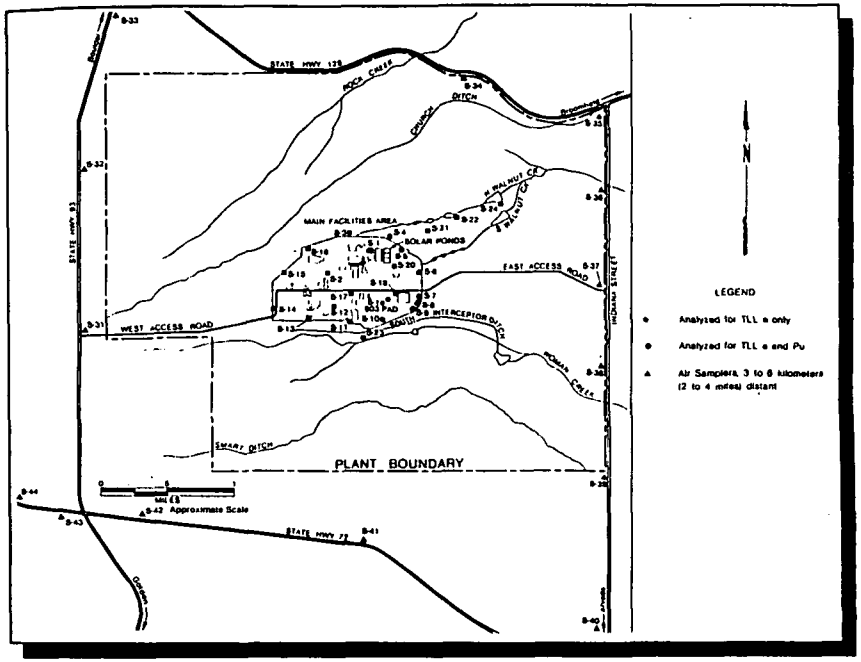

Figure 3
Location of Onsite and Perimeter Ambient Air Samplers at the Rocky Flats Plant in 1989

(Indiana Street), south (Highway 72) and west (Highway 93) (Figure 3). Community samplers (14) are located in metropolitan areas adjacent to RFP (Figure 4). Samplers operate continuously at a volumetric flow rate of approximately 12 liters per second (l/s) (25 cubic feet per minute [ft³/min]), collecting air particulates on 20 x 25-cm (8 x 10-in) fiberglass filters. Manufacturer's test specifications rate this filter media to be 99.97% efficient for relevant particle sizes under conditions typically encountered in routine ambient air sampling (SC82).

Filters were collected biweekly from onsite samplers and analyzed for total long-lived alpha activity. If results exceeded the RFP guide of 10×10^{-15} µCi/ml (3.7×10^{-4} Bq/m³), specific plutonium analysis was performed. No values exceeded the RFP guide in 1989. Routine plutonium analyses were performed biweekly for five onsite samplers that historically have shown highest total long-lived alpha activity. Starting January 1990, all onsite ambient air samples were analyzed monthly for plutonium-239 and -240. Filters from perimeter and community samplers are collected biweekly, composited by location and analyzed monthly for plutonium.

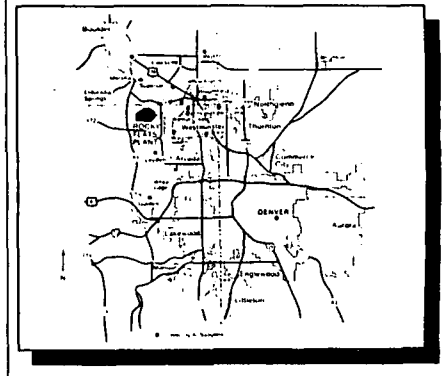

Figure 4
Location of Ambient Air Samplers in Communities Near the Rocky Flats Plant in 1989

TABLE 3.1-8

Plutonium Concentrations for Onsite Ambient Air Samplers at the Rocky Flats Plant in 1989[a]

Station	Number of Samples	Concentration ($\times 10^{-15}$ µCi/ml)[b,c] ^{C}min	^{C}max	^{C}mean	Standard Deviation (^{C}std)	Percent of DCG[d] (^{C}mean)
S-5	23	0.022	0.307	0.079	0.080	0.394
S-6	26	0.017	2.610	0.450	0.727	2.249
S-7	26	0.030	1.119	0.328	0.291	1.638
S-8	25	0.031	1.211	0.456	0.389	2.282
S-9	26	0.058	1.602	0.500	0.420	2.499
Overall	126	0.017	2.610	0.367	0.450	1.837

a. Air-sampling stations S-5, S-6, S-7, S-8 and S-9 are located in areas where the potential for elevated airborne radioactivity is greatest (see Figure 3).

b. Concentrations reflect monthly composites of biweekly station concentrations. ^{C}min=minimum composited concentration; ^{C}max=maximum composited concentration; ^{C}mean=mean composited concentration.

c. To obtain the proper concentration, multiply the numbers listed in the table by 1 x 10^{-15} µCi/ml. For example, the mean concentration at S-5 was 0.079 x 10^{-15} µCi/ml.

d. The interim standard calculated Derived Concentration Guide (DCG) for inhalation of class W plutonium by members of the public is 20 x 10^{-15} µCi/ml (Appendix D). Protection standards for members of the public are applicable for offsite locations. All locations in this table are on Rocky Flats Plant Property. DCGs for the public are presented here for comparison purposes only.

TABLE 3.1-9

Plutonium Concentrations for Rocky Flats Plant Perimeter Ambient Air Samplers in 1989

Station	Number of Samples	Concentration ($\times 10^{-15}$ µCi/ml)[a,b] ^{C}min	^{C}max	^{C}mean	Standard Deviation (^{C}std)	Percent of DCG[c] (^{C}mean)
S-31	12	-0.001	0.004	0.001	0.001	0.005
S-32	9	0.000	0.004	0.001	0.001	0.005
S-33	12	-0.001	0.001	0.000	0.001	0.001
S-34	12	-0.000	0.009	0.002	0.003	0.009
S-35	12	-0.001	0.002	0.001	0.001	0.004
S-36	11	0.000	0.008	0.002	0.002	0.009
S-37	12	0.000	0.006	0.003	0.002	0.015
S-38	12	0.000	0.005	0.002	0.001	0.009
S-39	12	-0.001	0.006	0.001	0.002	0.005
S-40	10	0.000	0.002	0.001	0.001	0.004
S-41	10	0.000	0.008	0.002	0.003	0.011
S-42	12	-0.000	0.003	0.001	0.001	0.004
S-43	12	-0.001	0.002	0.000	0.001	0.002
S-44	12	-0.001	0.005	0.001	0.002	0.004
Overall	160	-0.001	0.009	0.001	0.002	0.006

a. Concentrations reflect monthly composites of filters by station locations. ^{C}min=minimum composited concentration; ^{C}max=maximum composited concentration; ^{C}mean=mean composited concentration.

b. To obtain the proper concentration, multiply the numbers listed in the table by x 10^{-15} µCi/ml. For example, the mean concentration at S-31 was 0.001 x 10^{-15} µCi/ml.

c. The interim standard calculated Derived Concentration Guide (DCG) for inhalation of class W plutonium by members of the public is 20 x 10^{-15} µCi/ml (Appendix D). Differences in percent of DCG for the same reported mean concentration result from rounding differences utilizing raw data.

Results

Plutonium concentrations for onsite, perimeter and community samplers are given in Tables 3.1-8, 9 and 10, respectively. Overall mean plutonium concentration for onsite samplers was 0.367 x 10^{-15} µCi/ml (1.36 x 10^{-5} Bq/m³), 1.8% of the offsite DCG for plutonium in air (Appendix D, Table D-3). Overall mean plutonium concentrations for perimeter and community samplers were each 0.001 x 10^{-15} µCi/ml (3.7 x 10^{-8} Bq/m³). These values were less than 0.006% of offsite DCG for perimeter and community samplers. Differences in percent of DCG resulted from rounding values in raw data.

TABLE 3.1-10

Plutonium Concentrations for Community Ambient Air Samplers in 1989

Station	Number of Samples	Concentration ($\times 10^{-15}$ µCi/ml)[a,b] ^{C}min	^{C}max	^{C}mean	Standard Deviation (^{C}std)	Percent of DCG[c] (^{C}mean)
S-51 Marshall	12	-0.001	0.002	0.001	0.001	0.004
S-52 Jeffco Airport	12	0.000	0.025	0.003	0.007	0.015
S-53 Superior	9	-0.000	0.007	0.001	0.002	0.005
S-54 Boulder	11	0.000	0.003	0.001	0.001	0.005
S-55 Lafayette	12	0.000	0.004	0.001	0.001	0.003
S-56 Broomfield	10	0.000	0.003	0.001	0.001	0.005
S-57 Walnut Creek	12	-0.003	0.003	0.001	0.002	0.003
S-58 Wagner	10	-0.001	0.003	0.001	0.001	0.006
S-59 Leyden	12	0.000	0.003	0.001	0.001	0.006
S-60 Westminster	11	-0.001	0.004	0.001	0.002	0.005
S-61 Denver	11	-0.001	0.004	0.001	0.002	0.005
S-62 Golden	12	-0.001	0.003	0.001	0.001	0.004
S-68 Lakeview Pointe	12	0.000	0.004	0.001	0.001	0.006
S-73 Cotton Creek	10	-0.001	0.002	0.000	0.001	0.002
Overall	156	-0.003	0.025	0.001	0.002	0.005

a. Concentrations reflect monthly composites of filters by station locations. ^{C}min=minimum composited concentration; ^{C}max=maximum composited concentration; ^{C}mean=mean composited concentration.

b. To obtain the proper concentration, multiply the numbers listed in the table by 1 x $10m^{-15}$ µCi/ml. For example, the mean concentration at Marshall was 0.001 x 10^{-15} µCi/ml.

c. The interim standard calculated offsite Derived Concentration Guide (DCG) for inhalation of class W plutonium by members of the public is 20 x 10^{-15} µCi/ml (Appendix D). Differences in percent of DCG for the same reported mean concentration are the result of rounding differences utilizing raw data.

SURFACE WATER MONITORING

3.2

L. A. DUNSTAN

Rocky Flats Plant Surface Water Monitoring

Overview

Surface water management at RFP focuses on three drainage systems that receive runoff from the main facilities area. Each drainage contains earthen impoundments that restrict offsite discharges allowing water testing and, if necessary, treatment to meet quality standards.

North Walnut Creek. North Walnut Creek receives surface water runoff from the north side of the main facilities area (Figure 5). Ponds A-1 and A-2 are isolated from North Walnut Creek by valves that divert runoff via a surface pipeline into Pond A-3. In the past, these ponds were used for storage and evaporation of laundry water. This practice was discontinued in 1980. Ponds A-1 and A-2 currently are maintained to control possible chemical spills into the North Walnut Creek drainage basin. Runoff into these ponds is disposed of through natural evaporation and enhanced by spraying water through fog nozzles over the surface of the ponds. Excess water that does not evaporate is re-collected by the ponds. Holding Pond A-3 on North Walnut Creek is used to impound surface runoff for analysis prior to discharge. Pond A-4 is located farther downstream and provides secondary monitoring and control during normal flow and flood conditions.

South Walnut Creek. South Walnut Creek receives surface water runoff from the central portion of the main facilities area (Figure 5). This water is diverted past Ponds B-1, B-2, and B-3 via a culvert system to Pond B-4 and then to flood control Pond B-5 where the water is impounded for analysis prior to controlled offsite discharge. Pond B-5 discharges into South Walnut Creek. Pond B-4 is a flow-though pond with no operational holding capacity.

Ponds B-1 and B-2, in the central drainage, are reserved as backup control ponds. These ponds can be used to retain chemical spills, surface water runoff, or treated sanitary waste water.

Prior to 1979, treated sanitary waste water was discharged offsite through holding Ponds B-1 through B-4. From 1979 through 1989, this water was routed directly to Pond B-3 where it was held and then spray irrigated onto the RFP buffer zone areas as weather permitted. Pond B-5 serves as overflow capacity for Pond B-3 in the event of excess surface runoff or inability to spray irrigate.

Woman Creek. Woman Creek flows across the south side of RFP through the south drainage basin (Figure 5). This creek flows through surface water monitoring Pond C-1 and then, after bypassing Pond C-2, discharges offsite. Surface runoff from the south side of the RFP manufacturing areas is collected in an interceptor ditch. The interceptor ditch also collects runoff from a spray irrigation field. Flow from this ditch is routed to surface water control Pond C-2, where the water is impounded and analyzed before discharge.

Prior to discharge from Ponds A-4, B-5, and C-2, water is split-sampled with CDH and analyzed at independent EPA registered labs. Discharges are monitored for parameters listed in Appendix D (Table D-4) in compliance with EPA National Pollutant Discharge Elimination System (NPDES) permit limitations. In addition, water quality must meet temporary standards adopted on July 10, 1989, by the Colorado Water Quality Control Commission prior to release. These standards are listed in Appendix D (Tables D-5a through D-5e). In 1989, a new protocol was developed for discharges from Ponds A-4, B-5, and C-2. Samples are taken and split for analysis by CDH and EG&G Rocky Flats, Inc. Water is not released until CDH has assessed the results of analytical sampling.

Multiple samples were taken of discharges from Ponds A-4, B-5, and C-2 during 24-hr sample periods and composited for weekly analysis of plutonium, uranium, and americium. Weekly analysis of tritium, pH, nitrate (as nitrogen), and nonvolatile suspended solids were done also. Discharges from Pond C-1 and flow from Walnut Creek near its intersection with Indiana Street were sampled in a similar manner. Daily samples from Pond C-1 and Walnut Creek were analyzed for tritium and then composited into weekly samples for plutonium, uranium, and americium analysis.

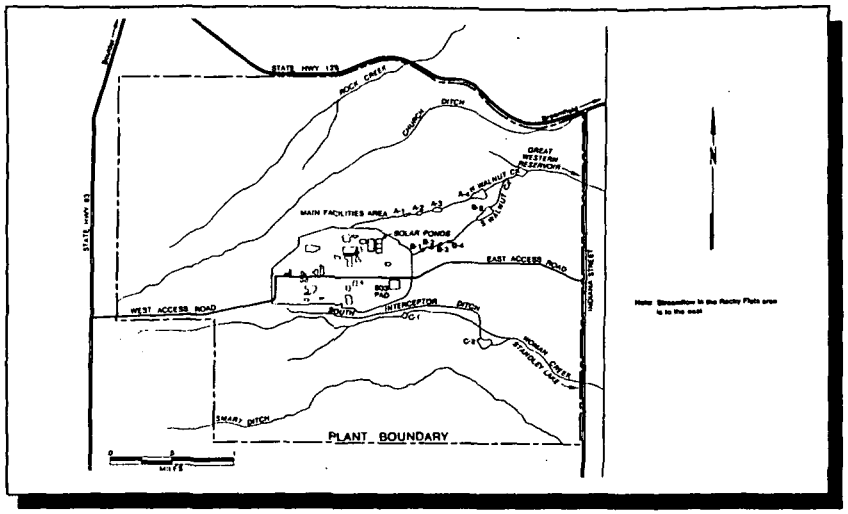

Figure 5
Holding Ponds and Liquid Effluent Water Courses at the Rocky Flats Plant

Results

Nonradiological Monitoring. Annual average concentrations of chemical and biological constituents measured in surface water effluent samples collected from Ponds A-3, A-4, B-3, B-5, and C-2 are presented in Table 3.2-1. These concentrations are indicative of the overall quality of effluent discharges. Certain discharges must meet NPDES permit monitoring and compliance limitations described in Appendix D (Table D-4). There were no exceedances of the NPDES permit in 1989.

Waste liquids containing PCBs and low levels of radioactivity are stored in approved storage facilities at RFP. These wastes were generated during a transformer cleanup and removal program that was completed during 1989 (Section 2.0, "Compliance Summary"). Monitoring for PCBs in downstream waters during 1989 showed no concentrations in excess of the laboratory minimum analytical detection limit of approximately 1 ppb.

Monitoring conducted in compliance with temporary standards adopted by CDH detected trace quantities of Atrazine and Simazine in Ponds A-4, B-5 and C-2. These herbicides were introduced through a vegetation control program at RFP. Use of both herbicides was discontinued in August 1989. Although no drinking water standards for these herbicides had been finalized, RFP elected to carbon filter the affected waters to remove Atrazine and Simazine residue before discharge. Further discussion of residue treatment is contained in Section 2.0, "Compliance Summary."

Radiological Monitoring. Concentrations of plutonium, uranium, americium, and tritium in water samples from the outfalls of Ponds A-4, B-5, C-1, C-2, and from Walnut Creek at Indiana Street are presented in Tables 3.2-2 and 3.2-3. Mean plutonium, uranium, americium, and tritium concentrations at all sample locations were less than 1.28% of applicable DCGs (Appendix D, Table D-3).

The annual cumulative total amount of plutonium, uranium, and americium discharged to offsite waters during the year was calculated using each individual discharge concentration and flow measurement. During 1989, cumulative discharge amounts were:

	A-4	B-5	C-2
Pu - Ci (Bq)			
	7.77×10^{-7}	4.39×10^{-6}	1.12×10^{-6}
	(2.87×10^{4})	(1.62×10^{5})	(4.14×10^{4})
U - Ci (Bq)			
	6.51×10^{-4}	3.47×10^{-4}	3.93×10^{-5}
	(2.41×10^{7})	(1.28×10^{7})	(1.45×10^{6})
Am - Ci (Bq)			
	5.92×10^{-7}	1.77×10^{-6}	2.16×10^{-7}
	(2.19×10^{4})	(6.55×10^{4})	(7.99×10^{3})

TABLE 3.2-1

Annual Average Concentrations of Chemical and Biological Constituents in Surface Water Effluents[a] at the Rocky Flats Plant in 1989

Parameters	Number of Analyses	C minimum[b]	C maximum[b]	C mean[b]
Discharge 001[c]				
pH, standard units	1	d	d	6.4
Nitrate as N, mg/l	1	d	d	7.14
Total Suspended Solids, mg/l	1	d	d	0
Total Residual Chlorine, mg/l	1	d	d	0.05
Total Chromium, mg/l	1	d	d	0.011
Total Phosphorus, mg/l	1	d	d	0.50
Fecal Coliform, #/100 ml	1	d	d	780/100ml
Biochemical Oxygen Demand (BOD_5), mg/l	1	d	d	2.64
Discharge 002[c]				
pH, standard units	13	7.0	7.9	N/A
Nitrate as N, mg/l	13	2.30	4.29	3.29
Discharge 003[c]	During 1989, there were no discharges from the Reverse Osmosis Pilot Plant.			
Discharge 004[c]	During 1989, there were no discharges from the Reverse Osmosis Plant.			
Discharge 005[c]				
pH, standard units	56	7.0	8.2	N/A
Nitrate as N, mg/l	56	0.18	7.80	1.90
Nonvolatile Suspended Solids, mg/l	56	0	4	0.61
Discharge 006[c]				
pH, standard units	82	6.0	8.3	N/A
Nitrate as N, mg/l	82	<0.02	2.57	0.93
Nonvolatile Suspended Solids, mg/l	79	0	236	6
Discharge 007[c]				
pH, standard units	18	7.0	7.9	N/A
Nitrate as N, mg/l	18	<0.02	1.43	<0.49
Nonvolatile Suspended Solids, mg/l	18	0	26	6

a. NPDES permit limitations are presented in Appendix D.
b. C minimum = minimum measured concentration; C maximum = maximum measured concentration; C mean = mean measured concentration.
c. The Environmental Protection Agency NPDES discharge permit defines the discharge locations as follows:
001 - Pond B-3
002 - Pond A-3
003 - Reverse Osmosis Pilot Plant
004 - Reverse Osmosis Plant
005 - Pond A-4
006 - Pond B-5
007 - Pond C-2
d. Minimum and maximum not reported because there was only one day of flow and one data set.

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TABLE 3.2-2

Plutonium, Uranium, and Americium Concentrations in Surface Water Effluents at the Rocky Flats Plant in 1989

Location	Number of Analyses	C minimum[a, c]	C maximum[a, c]	C mean[a, d]	Percent of DCG (C_{mean})
Plutonium Concentration (x 10^{-9} µCi/ml)[b]					
Pond A-4	17	-0.017 ± 0.027	0.053 ± 0.046	0.008 ± 0.016	0.03
Pond B-5	18	-0.018 ± 0.027	0.354 ± 0.082	0.003 ± 0.010	0.01
Pond C-1	37	-0.021 ± 0.030	0.070 ± 0.040	0.011 ± 0.006	0.04
Pond C-2	4	-0.007 ± 0.028	0.046 ± 0.037	0.019 ± 0.018	0.06
Walnut Creek at Indiana Street	25	-0.015 ± 0.028	0.087 ± 0.032	0.019 ± 0.005	0.06
Uranium Concentration (x 10^{-9} µCi/ml)[c]					
Pond A-4	17	4.48 ± 0.31	8.78 ± 0.48	6.41 ± 0.12	1.28
Pond B-5	18	0.44 ± 0.17	5.18 ± 0.36	2.58 ± 0.07	0.52
Pond C-1	37	0.20 ± 0.17	5.00 ± 0.42	1.55 ± 0.32	0.31
Pond C-2	4	1.08 ± 0.14	2.78 ± 0.25	1.54 ± 0.09	0.31
Walnut Creek at Indiana Street	25	1.55 ± 0.16	8.82 ± 0.50	4.62 ± 0.08	0.92
Americium Concentration (x 10^{-9} µCi/ml)[d]					
Pond A-4	17	-0.026 ± 0.030	0.109 ± 0.037	0.006 ± 0.008	0.02
Pond B-5	18	-0.020 ± 0.027	0.064 ± 0.035	0.013 ± 0.008	0.04
Pond C-1	37	-0.003 ± 0.024	0.075 ± 0.014	0.009 ± 0.006	0.03
Pond C-2	4	-0.009 ± 0.024	0.044 ± 0.034	0.003 ± 0.016	0.01
Walnut Creek at Indiana Street	25	-0.021 ± 0.027	0.121 ± 0.038	0.012 ± 0.004	0.04

a. C minimum= minimum measured concentration; C maximum = maximum measured concentration. For Pond C-1, C mean refers to calculated mean concentration. Due to intermittent flow meter operations at Pond C-1 during 1989, a volume weighted average was not possible to calculate. For Ponds A-4, B-5, C-2 and flow at Walnut Creek at Indiana Street, C mean refers to volume weighted averages.
b. Radiochemically determined as plutonium-239 and -240. The interim standard calculated Derived Concentration Guide (DCG) for plutonium in water available to members of the public is 30 X 10^{-9} µCi/ml (Appendix D).
c. Radiochemically determined as uranium-233, -234, and -238. The interim standard calculated DCG for uranium in water available to members of the public is 500 X 10^{-9} µCi/ml (Appendix D).
d. Radiochemically determined as americium-241. The interim standard calculated DCG for americium in water available to members of the public is 30 X 10^{-9} µCi/ml (Appendix D).
e. Calculated as 1.96 standard deviatons of the mean.
f. Calculated as 1.96 standard deviations of the individual measurement.

TABLE 3.2-3

Tritium Concentrations in Surface Water Effluents at the Rocky Flats Plant in 1989

Location	Number of Analyses	Tritium Concentration (x 10^{-9} µCi/ml)[b] C minimum[a, c]	C maximum[a, c]	C mean[a, d]	Percent of DCG (C_{mean})
Pond A-4	55	-470 ± 400	140 ± 110	-20 ± 50	0.000
Pond B-5	75	-590 ± 500	210 ± 330	-50 ± 40	0.000
Pond C-1	37	-440 ± 320	400 ± 390	30 ± 50	0.002
Pond C-2	19	-390 ± 400	260 ± 420	10 ± 60	0.0005
Walnut Creek at Indiana Street	75	-440 ± 420	500 ± 510	0 ± 60	0.000

a. C minimum = minimum measured concentration; C maximum = maximum measured concentration. For Pond C-1, C mean refers to calculated mean concentration. Due to intermittent flow meter operations at Pond C-1 during 1989, a volume weighted average was not possible to calculate. For Ponds A-4, B-5, C-2 and flow at Walnut Creek at Indiana Street, C mean refers to volume weighted averages.
b. The interim standard calculated Derived Concentration Guide (DCG) for tritium in water available to the members of the public is 2,000,000 x 10^{-9} mCi/ml (Appendix D).
c. Calculated as 1.96 standard deviations of the individual measurement.
d. Calculated as 1.96 standard deviations of the mean.

Tritium concentrations in water discharged from these ponds were within range of background concentrations. Therefore, cumulative discharge amounts were not calculated.

During 1989, RFP raw water supply was obtained from Ralston Reservoir and from the South Boulder Diversion Canal. Ralston Reservoir water usually contains more natural uranium radioactivity than the water flowing from the South Boulder Diversion Canal. During the year, uranium analyses were performed monthly on samples of RFP raw water. Concentrations are presented in Table 3.2-4. Average uranium concentration was 0.99 x 10^{-9} µCi/ml (0.04 Bq/l) or 0.001 µg/ml. Plutonium, americium, and tritium analysis results are also presented in this table. The average concentrations for these parameters were 0.007 x 10^{-9} µCi/ml (2.59 x 10^{-4} Bq/l), 0.000 x 10^{-9} µCi/ml (0.00 Bq/l), and 30 x 10^{-9} µCi/ml (1.11 Bq/l), respectively. These values can be used for comparison with the values measured in the RFP downstream discharge locations (Tables 3.2-2 and 3.2-3).

Community Water Monitoring

Overview

Community water monitoring includes sampling and analysis of public water supplies and tap water from several surrounding communities. Only Great Western Reservoir, one of the water supplies for the city of Broomfield, and Standley Lake Reservoir, a water supply for the cities of Westminster, Thornton and Northglenn, receive runoff from RFP drainage systems. The city of Federal Heights purchases a portion of their water supply from the city of Westminster. Weekly samples were collected and composited into a monthly sample, and analyses were performed for plutonium, uranium, and americium concentrations. Tritium and nitrate (as N) analyses were conducted on weekly grab samples.

Also, annual background samples were collected from three regional reservoirs: Ralston, Dillon and Boulder and from South Boulder Diversion Canal at distances ranging from 1.6 to 96 km (1 to 60 mi) from RFP. Samples were collected to determine background levels for plutonium, uranium, americium, and tritium in water.

Drinking water from Boulder, Broomfield, and Westminster was collected weekly, composited monthly and analyzed for plutonium, uranium, and americium. Analyses for tritium were performed weekly. Quarterly tap water samples were collected from the communities of Arvada, Denver, Golden, Lafayette, Louisville, and Thornton. These samples were analyzed for plutonium, uranium, americium, and tritium.

Results

Analyses of regional reservoir and drinking water samples are given in Tables 3.2-5 and 3.2-6. Plutonium, uranium, americium, and tritium concentrations for regional reservoirs represented 0.55% or less of the DCG. Average plutonium concentration in Great Western Reservoir was 0.006 x 10^{-9} µCi/ml (2.22 x 10^{-4} Bq/l) (0.20% DCG), which was within the range of concentrations predicted for Great Western Reser-

voir in the "Rocky Flats Plant Site Environmental Impact Statement" (US80a), based on known low-level plutonium concentrations in reservoir sediments.

Results of plutonium, uranium, americium, and tritium analyses for drinking water in nine communities were 0.31% or less of the applicable DCG. Drinking water standards have been adopted by the State of Colorado (CO77, CO81) and EPA (US76a) for alpha-emitting radionuclides (15×10^{-9} µCi/ml [5.55×10^{-1} Bq/l]) and for tritium ($20{,}000 \times 10^{-9}$ µCi/ml [7.4×10^{2} Bq/l]). These standards exclude uranium and radon. During 1989, the sum of the average concentrations of plutonium and americium (alpha-emitting radionuclides) for each community tap water location was 0.024×10^{-9} µCi/ml (8.88×10^{-4} Bq/l) or less. This value was 0.16% of the State of Colorado and EPA drinking water standards for alpha activity. Average tritium concentration in Great Western Reservoir, Standley Lake, and in all community tap water samples was 130×10^{-9} µCi/ml (4.81 Bq/l) or less. That value was typical of background tritium concentrations in Colorado and is less than 0.01% of the State of Colorado and EPA drinking water standard for tritium (CO81,US76a).

TABLE 3.2-4

Plutonium, Uranium, Americium, and Tritium Concentrations in the Rocky Flats Plant Raw Water Supply in 1989

Location	Number of Analyses	C minimum[a, g]	C maximum[a, g]	C mean[a, h]	Percent of DCG (C mean)
		Plutonium Concentration ($\times 10^{-9}$ µCi/ml)[b]			
Rocky Flats Raw Water	12	-0.021 ± 0.030	0.065 ± 0.034	0.007 ± 0.013	0.023
		Uranium Concentration ($\times 10^{-9}$ µCi/ml)[c]			
Rocky Flats Raw Water	12	0.31 ± 0.08	2.64 ± 0.18	0.99 ± 0.41	3.3
		Americium Concentration ($\times 10^{-9}$ µCi/ml)[d]			
Rocky Flats Raw Water	12	-0.026 ± 0.027	0.029 ± 0.026	0.000 ± 0.008	0.0
		Tritium Concentration ($\times 10^{-9}$ µCi/ml)[e]			
Rocky Flats Raw Water	12	-290 ± 290	200 ± 440	30 ± 90	0.002

a. C minimum=minimum measured concentration; C maximum-maximum measured concentration; C mean=mean calculated concentration.
b. Radiochemically determined as plutonium-239 and -240. The interim standard calculated Derived Concentration Guide (DCG) for plutonium in water available to members of the public is 30×10^{-9} µCi/ml (Appendix D).
c. Radiochemically determined as uranium-233, -234 and -238. The interim standard calculated DCG for uranium in water available to members of the public is 500×10^{-9} µCi/ml (Appendix D).
d. Radiochemically determined as americium-241. The interim standard calculated DCG for americium in water available to members of the public is 30×10^{-9} µCi/ml (Appendix D).
e. The interim standard calculated DCG for tritium in water available to members of the public is $2{,}000{,}000 \times 10^{-9}$ µCi/ml (Appendix D).
f. Source of Raw Water: Ralston Reservoir and South Boulder Diversion Canal.
g. Calculated as 1.96 standard deviations of the individual measurement.
h. Calculated as 1.96 standard deviations of the mean.

TABLE 3.2-5

Americium and Tritium Concentrations in Public Water Supplies Near the Rocky Flats Plant in 1989

Location	Number of Analyses	C minimum[a, c]	C maximum[a, c]	C mean[a, d]	Percent of DCG
Reservoir		**Americium Concentration ($\times 10^{-9}$ µCi/ml)[b]**			
Boulder	1	-0.003 ± 0.029	-0.003 ± 0.029	-0.003 ± 0.029	0.000
Dillon	1	-0.012 ± 0.028	-0.012 ± 0.028	-0.012 ± 0.029	0.000
Great Western	12	-0.003 ± 0.006	0.025 ± 0.012	0.005 ± 0.005	0.017
Ralston	1	0.023 ± 0.032	0.023 ± 0.032	0.023 ± 0.032	0.076
South Boulder Diversion Canal	1	-0.019 ± 0.027	-0.019 ± 0.027	-0.019 ± 0.027	0.000
Standley	12	-0.005 ± 0.008	0.026 ± 0.008	0.005 ± 0.005	0.017
Drinking Water					
Arvada	4	-0.002 ± 0.032	0.041 ± 0.031	0.021 ± 0.018	0.070
Boulder	12	-0.013 ± 0.031	0.015 ± 0.029	0.003 ± 0.004	0.010
Broomfield	12	-0.010 ± 0.031	0.021 ± 0.007	0.003 ± 0.004	0.010
Denver	4	-0.011 ± 0.024	0.053 ± 0.037	0.024 ± 0.033	0.080
Golden	4	-0.025 ± 0.031	0.039 ± 0.030	0.004 ± 0.028	0.013
Lafayette	4	-0.017 ± 0.029	0.026 ± 0.028	0.008 ± 0.019	0.026
Louisville	4	-0.013 ± 0.025	0.033 ± 0.034	0.007 ± 0.020	0.023
Thornton	4	-0.015 ± 0.028	0.016 ± 0.028	0.004 ± 0.013	0.013
Westminster	12	-0.005 ± 0.007	0.066 ± 0.031	0.006 ± 0.011	0.020
Reservoir		**Tritium Concentration ($\times 10^{-9}$ µCi/ml)[e]**			
Boulder	1	-10 ± 290	-10 ± 290	-10 ± 290	0.000
Dillon	1	0 ± 290	0 ± 290	0 ± 290	0.000
Great Western	51	-440 ± 400	230 ± 510	10 ± 30	0.001
Ralston	1	40 ± 150	40 ± 150	40 ± 150	0.002
South Boulder Diversion Canal	1	-40 ± 290	-40 ± 290	-40 ± 290	0.000
Standley	51	-390 ± 400	300 ± 430	0 ± 150	0.000
Drinking Water					
Arvada	4	-40 ± 100	210 ± 290	110 ± 100	0.006
Boulder	51	-470 ± 510	290 ± 300	0 ± 40	0.000
Broomfield	49	-480 ± 390	420 ± 530	-10 ± 40	0.000
Denver	4	-90 ± 330	-10 ± 100	-50 ± 30	0.000
Golden	4	-120 ± 330	80 ± 100	-20 ± 80	0.000
Lafayette	4	-30 ± 100	210 ± 400	50 ± 110	0.003
Louisville	4	-20 ± 100	290 ± 400	130 ± 140	0.007
Thornton	4	-120 ± 400	90 ± 100	10 ± 100	0.005
Westminster	51	-560 ± 500	470 ± 520	-30 ± 50	0.000

a. C minimum = minimum measured concentration; C maximum = maximum measured concentration; C mean = mean calculated concentration.
b. Radiochemically determined as americium-241. The interim standard calculated Derived Concentration Guide (DCG) for americium in water available to members of the public is 30×10^{-9} µCi/ml (Appendix D, Table D-3).
c. Calculated as 1.96 standard deviations of the individual measurements.
d. Calculated as 1.96 standard deviations of the mean.
e. The interim standard calculated DCG for tritium in water available to members of the public is $2{,}000{,}000 \times 10^{-9}$ µCi/ml (Appendix D, Table D-3).

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TABLE 3.2-6

Plutonium and Uranium Concentrations in Public Water Supplies Near the Rocky Flats Plant in 1989

Location	Number of Analyses	^{C} minimum[a, c]	^{C} maximum[a, c]	^{C} mean[a, d]	Percent of DCG (^{C}mean)
Reservoir		**Plutonium Concentration (x 10^{-9} µCi/ml)[b]**			
Boulder	1	0.000 ± 0.031	0.000 ± 0.031	0.000 ± 0.031	0.000
Dillon	1	-0.007 ± 0.029	-0.007 ± 0.029	-0.007 ± 0.029	0.000
Great Western	12	-0.003 ± 0.006	0.061 ± 0.038	0.006 ± 0.010	0.020
Ralston	1	0.002 ± 0.030	0.002 ± 0.030	0.002 ± 0.030	0.006
South Boulder Diversion Canal	1	0.053 ± 0.039	0.053 ± 0.039	0.053 ± 0.039	0.177
Standley	12	-0.009 ± 0.029	0.004 ± 0.007	0.000 ± 0.002	0.000
Drinking Water					
Arvada	4	-0.017 ± 0.030	0.031 ± 0.033	0.003 ± 0.020	0.010
Boulder	12	-0.004 ± 0.007	0.009 ± 0.008	0.001 ± 0.002	0.003
Broomfield	12	-0.009 ± 0.028	0.006 ± 0.013	0.000 ± 0.003	0.000
Denver	4	-0.008 ± 0.028	0.002 ± 0.036	-0.005 ± 0.005	0.000
Golden	4	-0.018 ± 0.030	0.007 ± 0.031	-0.001 ± 0.012	0.000
Lafayette	4	-0.012 ± 0.028	0.004 ± 0.034	0.000 ± 0.008	0.000
Louisville	4	-0.018 ± 0.034	0.002 ± 0.033	-0.008 ± 0.009	0.000
Thornton	4	-0.003 ± 0.031	0.008 ± 0.031	0.002 ± 0.005	0.006
Westminster	12	-0.016 ± 0.027	0.008 ± 0.008	0.000 ± 0.003	0.000
Reservoir		**Uranium Concentration (x 10^{-9} µCi/ml)[e]**			
Boulder	1	-0.08 ± 0.06	-0.08 ± 0.06	-0.08 ± 0.06	0.00
Dillon	1	0.65 ± 0.09	0.65 ± 0.09	0.65 ± 0.09	0.13
Great Western	12	0.88 ± 0.14	2.03 ± 0.23	1.37 ± 0.23	0.27
Ralston	1	2.75 ± 0.16	2.75 ± 0.16	2.75 ± 0.16	0.55
South Boulder Diversion Canal	1	0.25 ± 0.07	0.25 ± 0.07	0.25 ± 0.07	0.05
Standley	12	1.05 ± 0.15	3.44 ± 0.20	1.72 ± 0.34	0.34
Drinking Water					
Arvada	4	-0.08 ± 0.08	0.67 ± 0.12	0.43 ± 0.33	0.09
Boulder	12	-0.10 ± 0.06	0.75 ± 0.18	0.26 ± 0.17	0.05
Broomfield	12	0.32 ± 0.11	1.58 ± 0.20	0.93 ± 0.25	0.19
Denver	4	0.13 ± 0.11	0.89 ± 0.18	0.72 ± 0.64	0.14
Golden	4	0.14 ± 0.10	1.66 ± 0.20	0.80 ± 0.62	0.16
Lafayette	4	-0.06 ± 0.08	0.24 ± 0.16	0.10 ± 0.12	0.02
Louisville	4	-0.02 ± 0.07	0.19 ± 0.11	0.09 ± 0.10	0.02
Thornton	4	0.89 ± 0.09	2.45 ± 0.28	1.54 ± 0.64	0.31
Westminster	12	0.26 ± 0.11	1.32 ± 0.11	0.72 ± 0.20	0.14

a. ^{C} minimum = minimum measured concentration; ^{C} maximum = maximum measured concentration; ^{C} mean = mean calculated concentration.
b. Radiochemically determined as plutonium-239 and -240. The calculated Derived Concentration Guide (DCG) for plutonium in water available to members of the public is 30 x 10^{-9} µCi/ml (Appendix D, Table D-3).
c. Calculated as 1.96 standard deviations of the individual measurements.
d. Calculated as 1.96 standard deviations of the mean.
e. Radiochemically determined as uranium-233, -234, and -238. The calculated DCG for uranium in water available to members of the public is 500 x 10^{-9} µCi/ml (Appendix D, Table D-3).

GROUND WATER MONITORING

3.3

P. F. FOLGER, B. R. LEWIS

Overview

Ground water monitoring for radionuclides and other parameters has been conducted at RFP since 1960. Changes have occurred in recent years as environmental regulations have evolved and expanded. These changes have intensified characterization and assessment of ground water through installation of additional monitoring wells, analysis of additional analytes, and improvements in quality assurance. The ground water program now consists of 346 monitoring wells. Objectives of this program are: 1) to assess impacts on ground water quality from past and current operations at RFP; 2) to ensure compliance with federal, state, and local regulations; 3) to identify trends in ground water quality; and 4) to implement ground water protection and management strategies.

Hydrogeology

Two ground water flow systems exist at RFP; a shallow unconfined system in the Rocky Flats Alluvium and shallow paleochannel found immediately beneath the alluvium, and a confined system found in the deeper sandstone units of the Arapahoe and Laramie formations.

The Rocky Flats Alluvium lies directly beneath plant facilities and provides a gravelly cover on top of a bedrock pediment, varying in thickness of up to 31 m (100 ft) west of RFP and thinning to the east where it mostly becomes nonexistent (Figure 6). The saturated thickness of the Rocky Flats Alluvium is very seasonal with sizable areas becoming unsaturated during the late summer and winter months. Ground water flow is generally to the east in the alluvium.

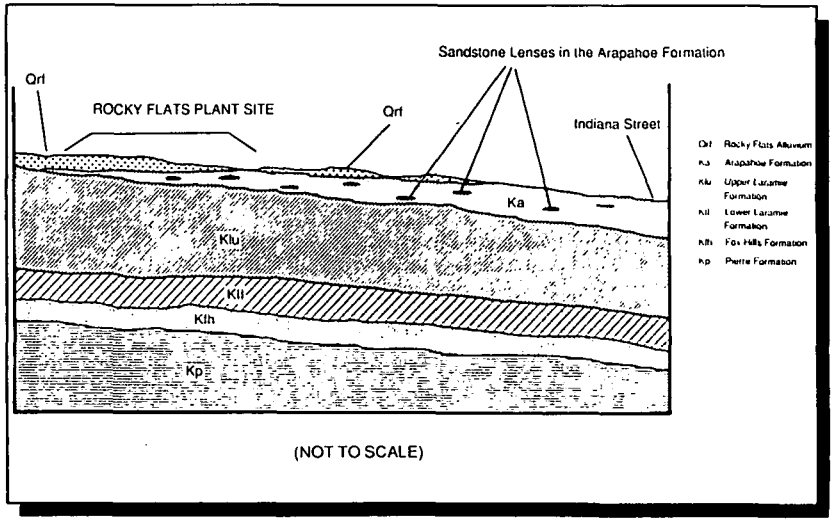

Figure 6
Generalized Cross Section of the Stratigraphy Underlying the Rocky Flats Plant.

However, localized directions may be toward the drainages or controlled by the eroded surface of the bedrock. Flow directions in the shallow paleochannel are controlled by channel morphology and surrounding aquitard lithologies but are generally to the east. Deeper, unconfined conditions occur in the weathered claystone bedrock. These areas do not contribute a significant quantity of ground water. Ground water flow in the lower, confined system found in the Arapahoe and Laramie formations is generally toward the east.

Geologic formations undergoing environmental investigations for potential contamination are the Rocky Flats Alluvium and the Arapahoe and portions of the Laramie formations. The uppermost sandstone unit of the Arapahoe Formation is in direct hydraulic connection with the Rocky Flats Alluvium. It is in these contact areas where contamination enters the bedrock. Present hydrogeologic understanding suggests there is not an immediate threat of ground water contamination leaving RFP via the ground water pathway. The other sandstone units within the Arapahoe formation do not appear to be of hydraulic importance because of their vertical separation. Further investigations are examining these other sandstone units.

Monitoring Procedures

A total of 193 wells were installed through 1987, and an additional 153 wells were added in 1989 to better characterize the geology, hydrogeology, and geochemistry of RFP (Figure 7). Table 3.3-1 shows the breakdown of monitoring wells installed before and during 1989 by area. Ground water samples are collected quarterly and analyzed for the parameters shown in Table 3.3-2. In addition to ground water chemistry, the water level is measured for each well. A complete round of ground water levels is recorded at the beginning of each sampling quarter to assess ground water flow directions. An additional 40 piezometers were installed within the 384-acre main facilities area to help characterize the ground water flow system (Table 3.3-1). At present, approximately 20,000 data items are collected on a quarterly basis from the ground water monitoring network at RFP.

Results

The Interagency Agreement (Section 2.0, "Compliance Summary"), divides RFP into ten operable units for study and cleanup. The following section discusses results of ground water investigations on Operable Units 1, 2 and 3. These units have received the highest priority in identifying contamination. Past investigations have been conducted on the remaining areas of RFP though not specific to Operable Units 4 through 10. Other future studies will focus on characterizing the level and extent of ground water contamination in these units.

Ground water investigations and restoration activities at RFP follow a five-phase plan to identify contamination, design and implement treatment procedures and monitor adequacy

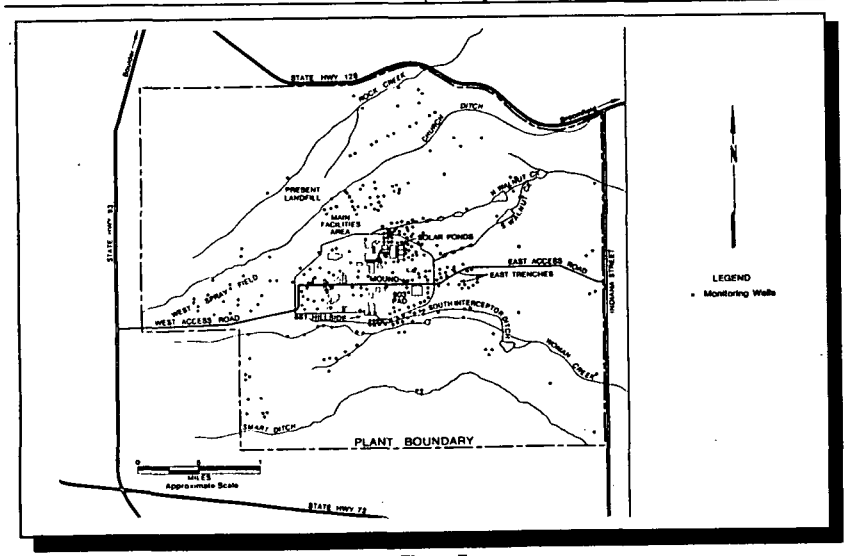

Figure 7
Location of Ground Water Monitoring Wells at the Rocky Flats Plant in 1989

TABLE 3.3-1
Ground Water Monitoring Wells at the Rocky Flats Plant in 1989

Location	Wells Installed In 1989	Wells Installed Before 1989	Total Numberof Wells Installed
Solar Ponds	32	33	65
Present Landfill	13	25	38
West Spray Field	8	18	26
Old Process Waste Line	3	2	5
903 Pad	—	15	15
Mound	—	14	14
East Trenches	4	27	31
881 Hillside	3	37	40
Piezometers[a]	40	—	40
Background	50	8	58
East Buffer Zone	—	14	14
TOTAL	153	193	346

a. Piezometers are located at various sites throughout RFP.

TABLE 3.3-2
Parameters Analyzed for Ground Water at the Rocky Flats Plant in 1989

FIELD PARAMETERS

pH
Specific Conductance
Temperature
Dissolved Oxygen

INDICATORS

Total dissolved solids

ANIONS

Carbonate
Bicarbonate
Chloride
Sulfate
Nitrate
Cyanide

ORGANICS

CLP[a] Target Compounds List
Oil and Grease

METALS

CLP[a] Target Analyte List
Cesium
Lithium
Molybdenum
Strontium
Tin

RADIONUCLIDES

Gross Alpha
Gross Beta
Uranium -233, -234, -235, -238
Americium-241
Plutonium -239, -240
Strontium-90
Cesium-37
Tritium
Radium-226, -228

a. Contract Laboratory Protocol

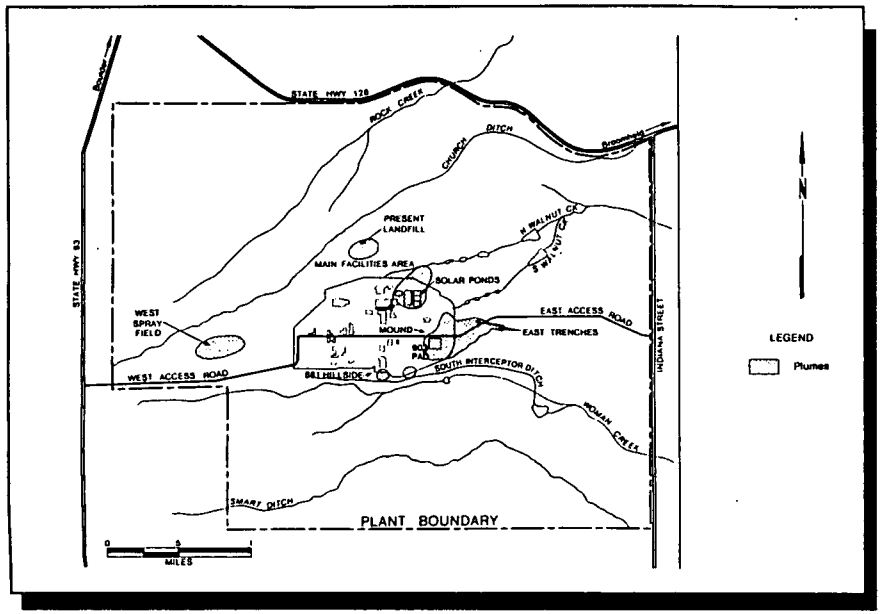

Figure 8

Location of Ground Water Contamination Areas at the Rocky Flats Plant in 1989

of restoration actions. This process includes establishment of ground water quality standards which are specific to each operable unit and reflect state and federal requirements. Operable Units 1, 2 and 3 are in various stages of investigation and restoration. No specific standards have been established for these operable units although possible limits have been identified pursuant to the CERCLA requirements that remedial actions comply with applicable or relevant and appropriate (ARAR) federal laws or more stringent promulgated state laws. In addition, the Colorado Water Quality Control Commission held an informational hearing on February 6, 1990, to receive testimony for determining the need to prepare regulations governing site-specific classifications and standards for ground water protection in the vicinity of RFP.

Operable Unit 1 (O.U.1)

881 Hillside

Information on ground water quality at O.U.1 was reported in the document "Draft Phase III RI/FS Work Plan, Rocky Flats Plant, 881 Hillside Area Operable Unit No. 1" (RI90). Volatile organic compound (VOC) contamination exists in the shallow ground water system under the 881 Hillside. Figure 8 shows the approximate outline of contaminated ground water plumes on the plantsite, and indicates the extent of contamination at O.U.1. Concentrations of the most common organic contaminants at O.U.1, trichloroethene (TCE), tetrachloroethene (PCE), and 1,1,1 trichloroethane (1,1,1, TCA) range up to 11,000 µg/l, 5,900 µg/l, and 15,000 µg/l, respectively, in samples collected during 1989. However, concentrations of this magnitude are very limited in extent. Maximum values for volatile organic compounds occurred within the boundaries of the solid waste management units (SWMU) 119.1 and 119.2 (Figure 9). These areas were used for barrel waste storage from 1967 to 1972. Concentrations of VOCs diminished rapidly downgradient of SWMU 119.1 and 119.2 to or below detection limits (5 µg/l) within 200 ft of the original storage area.

Above background Total Dissolved Solids (TDS) and major ion concentrations also occurred in unconfined groundwater at O.U.1. Some of these constituents have migrated farther downgradient than VOCs although they have not impacted the Woman Creek drainage directly south of O.U.1. Certain metals, including strontium (Sr), selenium (Se), and uranium (U) also were present above background concentrations at O.U.1 and generally occurred where major

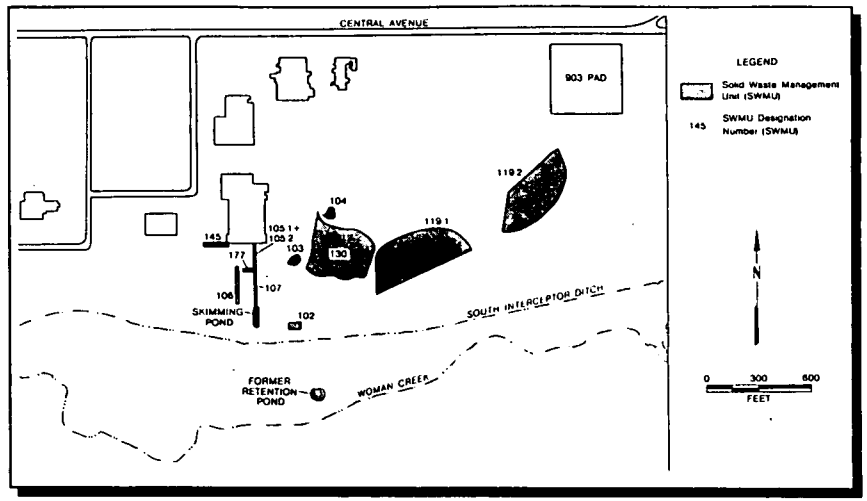

Figure 9

Solid Waste Management Units Numbers 119.1 and 119.2 at the Rocky Flats Plant

ion concentrations are also elevated. Uranium was the only radionuclide above background levels in the surficial ground water downgradient of SWMUs 119.1 and 119.2 and ranged up to 53 pCi/l (1.96 Bq/l).

Operable Unit 2 (O.U.2)

903 Pad, Mound Area, and East Trenches

Information on ground water quality at O.U.2 was reported in the document "Draft Phase II RF/FS Work Plan, Rocky Flats Plant, 903 Pad, Mound, and East Trenches Areas, Operable Unit No. 2" (RI89d). VOC contamination occurs in the surficial ground water system at O.U.2 (Figure 8) and consists primarily of elevated values of TCE, PCE and carbon tetrachloride (CCl_4). Elevated values of TCE best define the extent of contamination which extends approximately 183 m (600 ft) southeast of the 903 Pad to well 1487, and approximately 458 m (1,500 ft) to the northeast of the 903 Pad to well 3687 (Figure 10). TCE concentrations ranged up to 12,000 µg/l in monitoring wells at O.U.2 in 1989, but contamination of this magnitude was limited in extent. The geometric mean for TCE during the second quarter was 107 µg/l for 10 wells. Elevated PCE concentrations at O.U.2 were more limited in extent than TCE values, and were highest at the Mound Area (maximum value 45,000 µg/l during second quarter 1989). The extent of PCE contamination fell within the plume boundaries shown in Figure 8, but concentrations diminish south and east of the Mound Area to <100 µg/l at wells 0174 and 0374, respectively (Figure 10). CCl_4 contamination in the ground water was highest at the northern East Trenches and 903 Pad area, and ranged up to 1,100 µg/l with a geometric mean of 400 µg/l for the second quarter 1989 (9 wells).

VOC contamination occurs in the shallow bedrock ground water at O.U.2 where subcropping sandstone bodies are in hydraulic connection with the overlying alluvial ground water. However, deep bedrock groundwater has apparently not been impacted.

Certain inorganic parameters and radionuclides were elevated above background values in O.U.2, but did not comprise a well-defined plume of contamination. Investigations are currently underway to further characterize the magnitude and extent of contamination at O.U.2.

Operable Unit 3 (O.U.3)

Solar Ponds, West Spray Field, Present Landfill

Data on ground water quality at O.U.3 for 1989 was reported in the document "1989 Annual RCRA Ground-Water Monitoring Report for Regulated Units at Rocky Flats Plant" (EG90a).

Solar Ponds. Ground water in surficial materials at the Solar Ponds has been impacted by elevated amounts of nitrate, uranium, tritium, TDS, sulfate, chloride, and certain metals. Thirty-two monitoring wells were installed at the Solar

Ponds in 1989 to better characterize the nature and extent of contamination, and to investigate the distribution of a subcropping sandstone that may be considered part of the surficial ground water system. Data from samples collected in 1989 reaffirmed that the maximum concentrations of contaminants occurred in the immediate Solar Ponds area, and that concentrations fall off rapidly downgradient. Highest concentrations for TDS and nitrate (17,400 mg/l and 12,100 mg/l, respectively) occurred at the north side of the Solar Ponds from wells completed in weathered claystone. Highest values for U and tritium (H-3) (428 pCi/l [1.58 x 10^{10} Bq/l] and 9,000 pCi/l [3.33 x 10^{11} Bq/l], respectively]) occurred on the east side of the Solar Ponds in wells completed in alluvial materials. Other parameters commonly elevated in the immediate Solar Ponds area included strontium (Sr), sodium (Na), magnesium (Mg), chloride (Cl), and sulfate (SO_4).

Figure 8 shows a plume of contaminated surficial groundwater extending approximately 1,100 ft from the northeast corner of the Solar Ponds area. This plume represents elevated values for TDS, inorganics, and some metals. However, these values are generally lower than values for the same constituents in the immediate Solar Ponds area.

West Spray Field. Eight monitoring wells were installed at the West Spray Field in 1989 and completed in the Rocky Flats Alluvium to monitor the elevated nitrate concentrations within this unit. Water with elevated nitrate concentrations was spray irrigated at the West Spray Field from 1982-1985, resulting in modest increased nitrate and TDS values in the ground water. Results from 1988 and 1989 indicated that only one well consistently showed nitrate concentrations above 10 mg/l, and no higher than 20 mg/l. Other wells within the West Spray Field showed nitrate concentrations less than 10 mg/l. Bedrock ground water quality at the West Spray field does not appear to be impacted by higher nitrate concentrations in the alluvial ground water.

Present Landfill. Alluvial ground water within the Present Landfill (Figure 8) has been impacted by elevated TDS, major ions, barium (Ba), calcium (Ca), iron (Fe), manganese (Mn), zinc (Zn), Sr, SO_4, Mg, Cl, H-3, and U. Concentrations of these parameters were elevated at six wells within the Present Landfill boundaries. However, wells installed in 1989 and during previous years do not indicate contamination has extended past the boundaries of the present landfill. Highest values for TDS (597 mg/l), Sr (.67 mg/l), Fe (5.4 mg/l), Mn (3.9 mg/l), and U (18.4 pCi/l [6.8 x 10^{8} Bq/l]) occurred within the landfill boundaries. Bedrock water quality apparently has not been impacted by contaminated alluvial ground water, although some wells showed slightly elevated values for some metals, major ions, and TDS. These values may represent background bedrock water quality in the Present Landfill area.

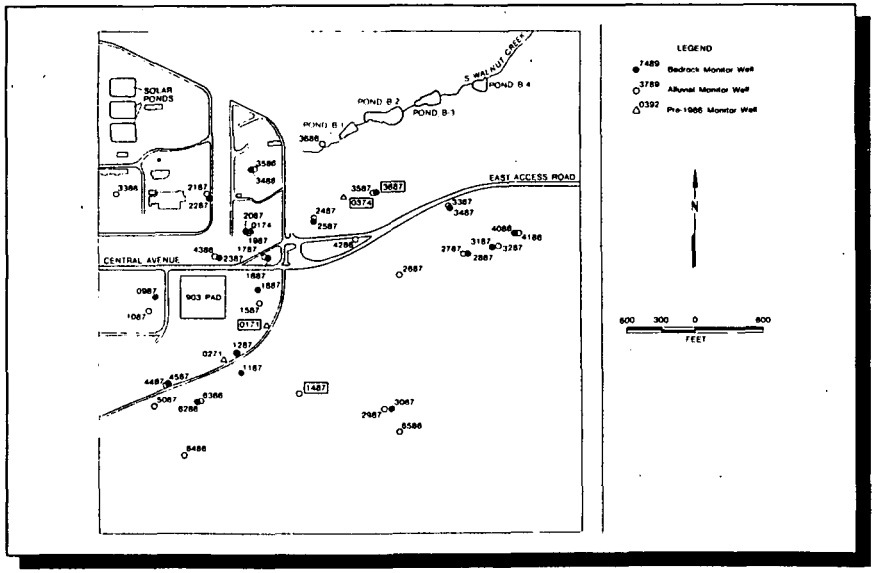

Figure 10
Monitoring Wells in Operable Unit No. 2 at the Rocky Flats Plant in 1989

Background Characterization Study

Fifty wells were installed in 1989 as part of a network to characterize upgradient groundwater unaffected by RFP (Figure 7). These wells were completed in different geological units to compare against wells on the main facilities area that were completed in the same geological unit. The background characterization program was designed to assess the spatial and temporal variability of naturally occurring constituents in various media (ground water, surface water, stream sediment, soil, and bedrock material). Representative background analytical data are necessary for meaningful interpretations of RCRA and CERCLA remedial investigations. These characteristics are compared statistically with data from a downgradient site to determine if a particular concentration represents a release to the environment. Analytes listed in Table 3.3-2 were sampled quarterly with the exception of volatile organic compounds. Volatile organic compounds do not occur naturally in the environment and therefore background concentrations were assumed not to be present.

Results showed that ground water in surficial materials (alluvium, colluvium, valley fill, and weathered bedrock) generally has similar water quality and can be classified as calcium bicarbonate water. Samples from the unweathered bedrock ground water system can be distinguished from the surficial system by relatively higher sodium and sulfate. Future samples will be collected quarterly from background wells to measure temporal and spatial variations in the ground water for comparison against downgradient wells. This will permit accurate assessment of potential releases of contaminants.

Geologic Characterization Study

Understanding the subsurface environments at RFP is a major component in correctly interpreting environmental data collected for RCRA and CERCLA activities. Since initiation of remedial investigations at the RFP, a substantial amount of geologic information has been obtained. This information is being integrated into an RFP geologic characterization report. This report will outline the overall tectonic framework of the region, but will focus on more relevant sedimentological characteristics and depositional environments of the Arapahoe and Laramie Formations that directly underlie RFP. The Arapahoe Formation is stratigraphically complex, and contains sandstone strata which may serve as contaminant pathways via ground water flow. High resolution seismic reflection was field tested and currently is being used to map stratigraphic complexities and quantify the hydrophysical system. Stratigraphic information as shallow as 6 m (20 ft) to approximately 92 m (300 ft) below ground surface and with approximately 0.9 m (3 ft) vertical and 0.3 m (1 ft) horizontal resolution is obtained. Integration of seismic data with other geologic information has accelerated development of a conceptual geologic model and quantification of hydrostratigraphic units. This model forms the basis for design in ground water monitoring networks at RFP.

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3.4 SOIL MONITORING

R. H. ZUCK

Overview

The purpose of the soil monitoring program at RFP is to evaluate changes in plutonium concentrations that might occur through soil resuspension or other mechanisms. Supplemental monitoring to measure background levels of plutonium was conducted in 1989 near eight Colorado communities located outside normal wind pattern dispersion areas for RFP. Concentrations of plutonium in these areas reflect residual global fallout from atmospheric testing of nuclear weapons.

Soils were sampled at RFP in October and November 1989 at 40 sites located on concentric circles, approximately 1.6 and 3.2 km radii (1 and 2 mi) from the center of RFP (Figure 11). Each monitoring site was adequately sized to allow yearly selection of non-overlapping sample areas. Within each site, two 1-m^2 frames were placed 1 m apart and soils were sampled at the corner and center locations of each frame (five locations per frame). Samples were obtained by driving a 10 x 10 centimeter (cm) (4 x 4 inches [in.]) cutting

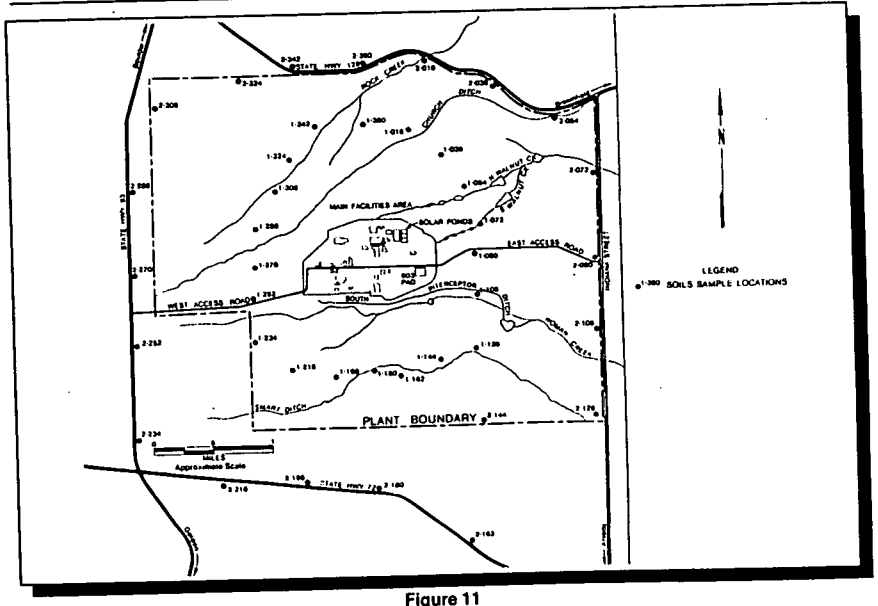


Figure 11
Soil Sampling Locations at the Rocky Flats Plant in 1989

Table 3.4-1

Plutonium Concentration in Soil Samples at the Rocky Flats Plant at One and Two Miles from the Plant Center, 1985 - 1989

Location	1985 Pu (pCi/g)[a,b,c,d]	1986 Pu (pCi/g)[a,b,c,d]	1987 Pu (pCi/g)[a,b,c,d]	1988 Pu (pCi/g)[a,b,c,d]	1989 Pu (pCi/g)[a,b,c,d]
Inner Circle:					
1-018	0.15 ± 0.02[d]	0.15 ± 0.02	0.18 ± 0.02	0.10 ± 0.01	0.08 ± 0.01
1-036	0.08 ± 0.01	0.10 ± 0.02	0.06 ± 0.01	0.88 ± 0.01	0.08 ± 0.01
1-054	0.02 ± 0.01	0.04 ± 0.01	0.04 ± 0.01	0.03 ± 0.01	0.13 ± 0.02
1-072	0.32 ± 0.03	0.63 ± 0.06	0.51 ± 0.05	0.37 ± 0.04	0.16 ± 0.02
1-090	1.00 ± 0.09	7.40 ± 0.62	7.05 ± 0.77	10.6 ± 0.98	2.52 ± 0.27
1-108	13.0 ± 1.30	15.0 ± 1.40	2.37 ± 0.21	10.4 ± 0.94	8.56 ± 0.81
1-126	1.90 ± 0.17	1.90 ± 0.18	2.75 ± 0.28	1.55 ± 0.14	1.08 ± 0.13
1-144	0.32 ± 0.03	0.27 ± 0.02	0.36 ± 0.04	0.20 ± 0.02	0.12 ± 0.01
1-162	0.10 ± 0.01	0.08 ± 0.01	0.17 ± 0.02	0.09 ± 0.01	0.06 ± 0.01
1-180	0.06 ± 0.01	0.06 ± 0.01	0.10 ± 0.01	0.06 ± 0.01	0.08 ± 0.01
1-198	0.16 ± 0.02	0.16 ± 0.02	0.21 ± 0.02	0.10 ± 0.01	0.05 ± 0.01
1-216	0.05 ± 0.01	0.10 ± 0.01	0.16 ± 0.02	0.05 ± 0.01	0.05 ± 0.01
1-234	0.05 ± 0.01	0.04 ± 0.01	0.05 ± 0.01	0.05 ± 0.01	0.05 ± 0.01
1-252	0.14 ± 0.02	0.11 ± 0.01	0.21 ± 0.03	0.09 ± 0.01	0.08 ± 0.01
1-270	0.07 ± 0.01	0.08 ± 0.01	0.09 ± 0.01	0.07 ± 0.01	0.06 ± 0.01
1-288	0.05 ± 0.01	0.05 ± 0.01	0.06 ± 0.01	0.03 ± 0.01	0.06 ± 0.01
1-306	0.09 ± 0.01	0.17 ± 0.02	0.21 ± 0.03	0.12 ± 0.01	0.10 ± 0.01
1-324	0.15 ± 0.02	0.21 ± 0.02	0.24 ± 0.03	0.16 ± 0.02	0.07 ± 0.01
1-342	0.02 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.02 ± 0.01	0.04 ± 0.01
1-360	0.11 ± 0.01	0.19 ± 0.02	0.16 ± 0.02	0.12 ± 0.02	0.08 ± 0.01
Outer Circle:					
2-018	0.04 ± 0.01	0.03 ± 0.01	0.04 ± 0.01	0.02 ± 0.00	0.02 ± 0.01
2-036	0.02 ± 0.01	0.07 ± 0.01	0.10 ± 0.01	0.07 ± 0.01	0.04 ± 0.01
2-054	0.03 ± 0.01	0.05 ± 0.01	0.10 ± 0.01	0.03 ± 0.01	0.06 ± 0.01
2-072	0.33 ± 0.03	0.23 ± 0.02	0.36 ± 0.04	0.11 ± 0.01	0.46 ± 0.06
2-090	2.50 ± 0.25	5.30 ± 0.48	4.48 ± 0.52	7.12 ± 0.67	1.94 ± 0.23
2-108	0.41 ± 0.04	0.46 ± 0.04	0.57 ± 0.06	0.47 ± 0.05	0.53 ± 0.06
2-126	0.42 ± 0.04	0.44 ± 0.05	0.40 ± 0.04	0.03 ± 0.01	0.28 ± 0.04
2-144	0.04 ± 0.01	0.04 ± 0.01	0.08 ± 0.01	0.35 ± 0.03	0.03 ± 0.01
2-162	0.01 ± 0.00	0.02 ± 0.01	0.03 ± 0.01	0.02 ± 0.01	0.02 ± 0.01
2-180	0.11 ± 0.01	0.04 ± 0.01	0.03 ± 0.01	0.03 ± 0.01	0.08 ± 0.01
2-198	0.02 ± 0.01	0.08 ± 0.01	0.14 ± 0.02	0.10 ± 0.01	0.01 ± 0.01
2-216	0.04 ± 0.01	0.06 ± 0.01	0.07 ± 0.01	0.07 ± 0.01	0.07 ± 0.01
2-234	0.05 ± 0.01	0.05 ± 0.01	0.07 ± 0.01	0.03 ± 0.01	0.05 ± 0.01
2-252	0.04 ± 0.01	0.07 ± 0.01	0.06 ± 0.01	0.04 ± 0.01	0.04 ± 0.01
2-270	0.04 ± 0.01	0.06 ± 0.01	0.08 ± 0.01	0.06 ± 0.01	0.06 ± 0.01
2-288	0.04 ± 0.01	0.05 ± 0.01	0.13 ± 0.02	0.07 ± 0.01	0.08 ± 0.01
2-306	0.06 ± 0.01	0.02 ± 0.01	0.08 ± 0.01	0.02 ± 0.00	0.04 ± 0.01
2-324	0.04 ± 0.01	0.09 ± 0.01	0.08 ± 0.01	0.14 ± 0.02	0.06 ± 0.01
2-342	0.13 ± 0.01	0.12 ± 0.01	0.14 ± 0.02	0.10 ± 0.01	0.06 ± 0.01
2-360	0.09 ± 0.01	0.05 ± 0.01	0.08 ± 0.01	0.05 ± 0.01	0.04 ± 0.01

a. Not blank corrected.
b. Sampled to a depth of 5 cm.
c. Concentrations are for the fraction of soil measuring less than 2mm in diameter.
d. Error term represents two standard deviations.

Table 3.4-2

Plutonium Concentration in Soil Samples Taken Near Colorado Communities in 1989

Location	Pu (pCi/g)[a,b,c,d]
Burlington	.01 ± .004
Crooke	.03 ± .006
Limon	.02 ± .005
Livermore	.03 ± .006
Loveland	.05 ± .009
Penrose	.08 ± .014
Springfield	.03 ± .008
Walsenburg	.05 ± .009

a. Not blank corrected.
b. Sampled to a depth of 5 cm.
c. Concentrations are for the fraction of soil measuring less than 2 mm in diameter.
d. Error term represents two standard deviations.

tool 5 cm (2 in.) into the soil and excavating the tool cavity. A single composite sample was formed for each monitoring site by combining sub-samples from both frames.

Soils were sampled near eight Colorado communities (shown in Figure 12) in May 1989. Sites were selected on the basis of topographic stability and the absence of aggradational deposits or erosion. Soils were sampled to a depth of 5 cm (2 in.).

Laboratory analysis was performed to determine plutonium concentration, expressed as pCi/g.

Results

Table 3.4-1 presents soil plutonium concentrations for 1985 through 1989. Samples taken in 1989 from the inner concentric circle (1.6 km radius) ranged from 0.04 pCi/g (1.48×10^{-3} Bq/g) to 8.56 pCi/g (3.17×10^{-1} Bq/g). Samples from the outer concentric circle (3.2 km) ranged from 0.01 pCi/g (3.7×10^{-4} Bq/g) to 1.94 pCi/g (7.18×10^{-2} Bq/g).

As in previous years, values were elevated in 1989 for sites 1-090, 1-108, 1-126, 2-090, 2-108, and 2-126 located east of the main facilities area (Figure 11). Contamination of these sites probably originated from the area known as the 903 Pad. Steel drums were used to store plutonium-contaminated industrial oils on the 903 area from 1958 through 1968. Leakage from these drums contaminated surface materials. Plutonium particles entrapped in the fine fraction of these surface materials were subsequently airlifted by winds and deposited on soils in a southeast-trending plume. Data from previous years has consistently shown elevated values from these sites. Annual variability in plutonium concentrations occurs because of non-uniform deposition by wind, subsequent redistribution by erosion and fauna, sample variability, and sampling/analytical error.

Soil plutonium concentrations in samples taken near Colorado communities are given in Table 3.4-2. Values ranged from 0.01 pCi/g (5.2×10^{-4} Bq/g) near Burlington to 0.08 pCi/g (2.85×10^{-3} Bq/g) near Penrose.

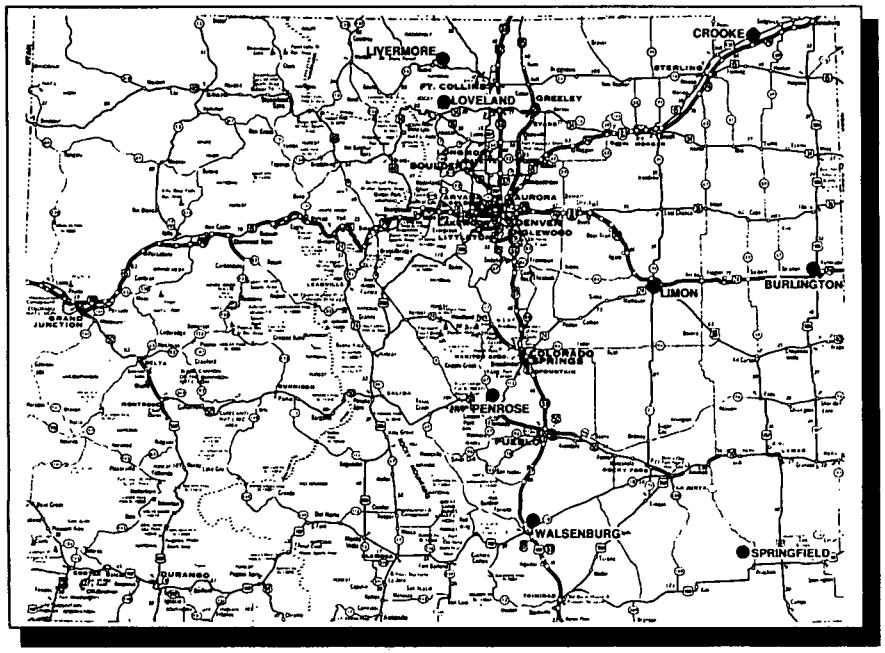


Figure 12
Soil Sampling Locations Near Colorado Communities in 1989

3.5 EXTERNAL GAMMA RADIATION DOSE MONITORING

N. M. DAUGHERTY

Overview

Thermoluminescent dosimeters (TLDs) are used to measure external penetrating gamma radiation exposure at 46 locations on and off RFP. Replicate TLDs are located at each site. All TLDs are replaced after an exposure of approximately 3 months. The TLDs are placed at 18 locations within the property enclosed by the security fence. Measurements are also made at 16 perimeter locations 3 to 6 km (2 to 4 mi) from the center of RFP and in 12 communities located within 50 km (30 mi) of RFP. The TLDs are placed at a height of about 1 m (3 ft) above ground level.

During 1983, conversion from a Harshaw TLD system to a Panasonic system was initiated. For one complete calendar year, two TLDs of each type were used at each monitoring location. Beginning in 1984, only Panasonic TLDs have been used.

The environmental TLDs consist of two Panasonic 802 dosimeters, each of which has four elements. Only one of the elements of each dosimeter is used. This element consists of calcium sulfate, thulium drifted ($CaSO_4$:Tm), deposited on a polymid surface. The phosphor is covered with a clear teflon and backed with an opaque ABS plastic. The TLDs are packaged in a small plastic bag, a paper envelope, and another plastic bag to protect them from the weather. Total filtration over the phosphor is 178.5 milligrams per square centimeter (mg/cm^2).

The environmental dosimeters have been individually calibrated (three times each) against an onsite Cs-137 gamma calibration source. Calibration linearity studies have confirmed that TLD response is linear for exposure levels ranging from 10 mrem to 1000 mrem. The mean calibration factor for each dosimeter is applied to measurements taken with that dosimeter. An additional correction is applied to correct for day-to-day variations in reader calibration.

It was determined that a statistically significant ($p=0.05$) difference in response exists between the Harshaw environmental monitoring system and the Panasonic environmental monitoring systems. To compare 1989 values with the previously reported Harshaw data, it is necessary to multiply the Panasonic results given in Table 3.5-1 by 1.046.

The annual dose equivalent for each location category was calculated by determining the average millirem per day (mrem/day) for each of the three categories, using data from the four quarters of 1989. These values were then multiplied by 365.25 to obtain yearly totals.

In previous annual reports, the Annual Measured Dose was reported with a 95% confidence interval on the mean using the standard error of the mean, calculated from the variance of the individual measured values. Beginning in 1985, the 95% confidence interval on an individual observation within each location category, calculated as 1.96 standard deviations, was added to the report. This latter interval may be used for assessing the variability of the individual location measurements within a location category.

Results

The 1989 environmental measurements using TLDs are summarized in Table 3.5-1. The average annual dose equivalents, as measured onsite, in the perimeter environs, and in local communities, were 167, 138, and 159 mrem (1.67, 1.38, and 1.59 millisieverts [mSv]), respectively. These values are indicative of background gamma radiation in the area (NA87a).

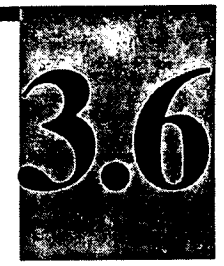
TABLE 3.5-1

Environmental Thermoluminescent Dosimeter Measurements at the Rocky Flats Plant in 1989

Location Category	Number of Locations	Number of Measurements	Mean Annual Measured Dose (mrem)	95% Confidence Interval on the Mean (mrem)[a]	95% Confidence Interval on an Individual Measurement (mrem)[b]
Onsite	18	132	167	±6	±74
Perimeter	16	104	138	±5	±55
Community	12	83	159	±7	±61

NOTE: The annual background gamma radiation dose in the Denver area ranges from about 125 - 190 mrem (NA87a).

a. Calculated as 1.96 standard deviations of the mean.
b. Calculated as 1.96 standard deviations of the individual measurements.



ASSESSMENT OF POTENTIAL PLANT CONTRIBUTION TO PUBLIC RADIATION DOSE

N. M. DAUGHERTY

Overview

An overview of basic radiation concepts is provided in Appendix C, "Perspective on Radiation." The following is a more detailed discussion of methodologies and results of an assessment of the radiation dose to the public which could result from activities at RFP.

Rocky Flats Plant Radioactive Materials

Radioactive materials included in calculating radiation dose to the public from RFP activities are plutonium, uranium, americium, and tritium. Internal exposure to alpha radiation emissions from inhalation and water ingestion of plutonium, uranium, and americium is the primary contributor to the projected radiation dose. Previous pathways assessments in the "Rocky Flats Plant Site Environmental Impact Statement" indicated swimming and consumption of foodstuffs are relatively insignificant contributors to public radiation dose (US80a). Swimming and fishing are limited in the area, and most locally consumed food is produced at considerable distances from the plant. Current pathway analysis is being reviewed to ensure that appropriate pathways are included in the dose assessment methodology.

Radiation Protection Standards for the Public

Standards for protection of the public from radiation are based on radiation dose. Radiation dose is a means of quantifying the biological effect or risk of ionizing radiation. In the United States, the unit commonly used to express radiation dose is the rem or the millirem (1 rem = 1,000 mrem). The comparable International Standard (SI) unit of radiation dose is the sievert (1 sievert [Sv]=100 rem). A rem is a unit of biological dose that expresses biological damage on a common scale. Radiation protection standards for the public are annual standards, based on the projected radiation dose from a year's exposure to or intake of radioactive materials.

Radiation protection standards applicable to DOE facilities are based on recommendations of national and international radiation protection advisory groups and on radiation protection standards set by other federal agencies. Pending final revision of radiation protection standards for the public, DOE adopted revised interim radiation protection standards for DOE environmental activities in 1985 (VA85). These interim standards incorporate guidance from the National Council on Radiation Protection and Measurements (NCRP), the International Commission on Radiological Protection (ICRP) and the Clean Air Act National Emission Standards for Hazardous Air Pollutants (NESHAP), as implemented in 40 CFR 61, Subpart H (US85). Effective December 15, 1989, EPA revised NESHAP standards for airborne emissions of radionuclides from DOE facilities (US89b). These new standards will apply to air emissions beginning in 1990.

Appendix D (Table D-1) summarizes interim DOE radiation protection standards for the public as established in 1985. The revised NESHAP standards of December 15, 1989, are presented for comparison purposes.

Radiation Dose

Radiation dose is calculated by multiplying radioactivity concentrations in air and water or on contaminated surfaces by assumed intake rates (for internal exposures) or exposure

times (for external exposure to penetrating radiation). These products are then multiplied by the appropriate radiation dose conversion factors as follows:

Radiation Dose =
(Radioactivity Concentration) X
(Intake Rate or Exposure Time) X
(Radiation Dose Conversion Factor)

In calculating radiation dose equivalent, differences in the biological effect of different types of ionizing radiation (e.g., alpha, beta, gamma rays or X-rays) are accounted for in the calculation. Radiation energy absorbed in the tissue of interest is first calculated and then multiplied by a modification factor based on the type and energy of the ionizing radiation involved. One millirem of dose equivalent from alpha radiation would have the same biological effect on an organ as one millirem of dose equivalent from gamma radiation.

Effective dose equivalent is a means of calculating radiation dose that allows comparisons of the total health risk of cancer mortality and serious genetic defects from exposures of different types of ionizing radiation to different body organs. It is calculated by first determining the dose equivalent to those organs receiving significant exposures, multiplying each organ dose equivalent by a health risk weighting factor, and summing those products. One millirem of effective dose equivalent from natural background radiation would have the same health risk (from cancer mortality and genetic defects) as one millirem of effective dose equivalent from artificially produced sources of radiation, regardless of which organ(s) receive the dose.

Radioactivity Concentration

Radioactivity concentrations or source terms used in calculating dose can be determined from actual samples and measurements in the environment taken at the locations of interest. Alternatively, for airborne releases, these concentrations can be calculated by modeling the atmospheric dispersion of air emissions from buildings and contaminated land areas.

In the following dose assessment, environmental measurements are used to determine compliance with the DOE radiation standards for all pathways. These measurements are used to calculate annual average concentrations of radioactive materials in air and water at the RFP boundary and in neighboring communities.

As required in federal regulation 40 CFR 61, EPA-approved computer codes are used to determine compliance with Clean Air Act NESHAP radionuclide emissions standards for the air pathway only. EPA-approved codes, AIRDOS-EPA and RADRISK, include both air dispersion modeling of air emissions from buildings and contaminated land areas and dose conversion factors for calculating final radiation dose.

Intake Rate or Exposure Time

Intake rates of radioactive materials used to represent inhalation and ingestion for 1 yr are prescribed by the DOE (US88a). These rates are based on recommendations of the ICRP (IN75). The breathing and water ingestion rates for 1 yr are 8,400 cubic meters (m^3) and 730 liters (l), respectively. Exposure times for external penetrating radiation are assumed to be 1 yr.

Radiation Dose Conversion Factors

Radiation dose conversion factors used for determining compliance with DOE standards for all pathways are prescribed by DOE (US88a, US88b). Dose conversion factors for internal exposures are based on recommendations of the ICRP (IN79). Dose conversion factors for external exposures to penetrating radiation are based on a methodology developed at Oak Ridge National Laboratory (KO81, KO83), with modifications by the original author (US88b).

Relative abundances of plutonium and americium isotopes in plutonium typically used at RFP (Table 3.6-1) were used to calculate composite dose conversion factors for plutonium and americium in air and water. Fractions of ingested radionuclides absorbed from the gastro-intestinal tract and lung clearance classes for inhaled radionuclides were chosen to maximize the associated dose conversion factors and the resulting radiation dose. Each dose conversion factor is for a 50-yr dose commitment from 1 yr of chronic exposure. That is, the dose that an individual could receive for 50 yr following 1-yr's chronic intake of radioactive material is calculated. The dose conversion factors used in this assessment are listed in Table 3.6-2. These dose conversion factors incorporate intake rates and exposure times discussed above.

EPA-approved computer codes used to determine compliance with the Clean Air Act NESHAP standards for the air pathway incorporate EPA's own approved dose conversion factors.

Dose Assessment Source Terms

Dose assessment for 1989 was conducted for several locations: RFP property boundary, nearby communities, and sites to a distance of 80 km (50 mi). Following is a description of the radionuclide concentrations (source terms) used for calculating the radiation dose to the public for all pathways.

Plutonium and americium in RFP environs are the combined result of residual fallout deposition from global atmospheric nuclear weapons testing and releases from the plant. Uranium,

TABLE 3.6-1

Isotopic Composition of Plutonium Used at the Rocky Flats Plant (US80a)

Isotope	Relative Weight (Percent)	Specific Activity (Ci/g)	Relative Activity[a] (Ci/g)	Fraction of Pu Alpha Activity[b]
Pu-238	0.01	17.1	0.00171	0.0233
Pu-239	93.79	0.0622	0.05834	0.7962
Pu-240	5.80	0.228	0.01322	0.1804
Pu-241	0.36	103.5*	0.37260*	5.085*
Pu-242	0.03	0.00393	1.18×10^{-6}	1.61×10^{-5}
Am-241	-	-	-	0.20[c]

* Beta Activity

a. Obtained by multiplying the percent by weight by the specific activity.
b. Obtained by dividing the relative activity by the sum of the relative activities for the plutonium alpha emitters.
c. The value for Am-241 is taken to be 20% of the plutonium alpha activity.

a naturally occurring element, is indigenous to many parts of Colorado and is used in RFP operations in various isotopic ratios. Tritium is both naturally occurring and produced artificially. Tritium is sometimes handled in RFP operations.

The ingestion source terms were based on measured concentrations of plutonium, americium, uranium, and tritium in water. Ground-plane source terms of penetrating radiation exposure from contaminated soil areas were based on past measured values of plutonium in soil and an assumed ratio of 0.20 for the americium to plutonium alpha activity in the soil. Inhalation source terms for the 1989 dose assessment were based on plutonium-239 and -240 concentrations measured in ambient air samples. Although it is known that much of this plutonium in air is from residual fallout from past global atmospheric weapons testing, for the purposes of this dose assessment it was conservatively assumed that all plutonium originated from RFP.

Maximum Site Boundary. The maximum site boundary dose assessment assumes an individual is present continuously at the RFP perimeter, though this area actually is uninhabited.

The plutonium inhalation source term of 3×10^{-18} µCi/ml (1×10^{-7} Bq/m^3) was the maximum annual average concentration of plutonium-239 and -240, as measured for a single location in the perimeter ambient air sampling network.

The water supply for an individual at the RFP boundary was assumed to be Walnut Creek, which intermittently flows offsite and provides the liquid effluent source term at the site boundary. During 1989, plutonium concentration in Walnut Creek averaged 1.9×10^{-11} µCi/ml (7.0×10^{-4} Bq/l). Average americium concentration was 1.2×10^{-11} µCi/ml (4.4×10^{-4} Bq/l). These concentrations were used as the water ingestion source term for the maximum site boundary dose assessment. The average concentration of uranium in Walnut Creek was 4.6×10^{-9} µCi/ml (1.7×10^{-1} Bq/l) and average concentration in incoming raw water was 9.9×10^{-10} µCi/ml (3.7×10^{-2} Bq/l). The source term for uranium ingestion was the difference between these two values (3.6×10^{-9} µCi/ml [1.3×10^{-1} Bq/l]). The average tritium concentration in Walnut Creek was 0 ± 60 µCi/ml and within the background range typically measured in regional waters. Tritium is an insignificant contributor to dose.

Ground-plane irradiation by external penetrating radiation from contaminated soil areas also is an insignificant contributor to dose. External penetrating radiation associated with radioactive materials of importance at RFP is generally of low energy and intensity. The ground-plane irradiation source term used for this assessment is based on the maximum plutonium concentration in soil measured at the RFP perimeter, as reported by the Environmental Measurements Laboratory (US70). This source term is 3×10^{2} µCi/m^2 (1×10^{3} becquerels per square meter [Bq/m^2]). Americium is assumed to be present at an alpha activity level of 20% of plutonium (US80a). The americium source term is estimated at 6×10^{-3} microcuries per square meter (µCi/m^2) (2×10^{2} Bq/m^2).

Community Locations. Air inhalation is considered the most significant pathway for radiation exposure to the public in community locations. Only two raw water supplies, Great Western Reservoir and Standley Lake, receive water from drainages crossing RFP, and input from these drainages is a small contribution to total volume of water in these reservoirs. As stated previously, ground-plane irradiation from penetrating radiation found in contaminated soil is an insignificant contribution to dose at the RFP boundary. Soil concentrations at more distant community locations would be much less.

Table 3.6-2

Dose Conversion Factors Used in Dose Assessment Calculations for the Rocky Flats Plant in 1989

INHALATION [REM · MILLILITER / MICROCURIE] [a,b]

Organ	Pu-239, -240
Effective Dose Equivalent	5.71×10^{12}
Liver	2.22×10^{13}
Bone Surfaces	1.04×10^{14}
Lung	1.08×10^{13}

WATER INGESTION [REM · MILLILITER / MICROCURIE] [a,c]

Organ	Pu-239, -240	Am-241	U-233, -234, -238
Effective Dose Equivalent	3.53×10^{6}	3.29×10^{6}	1.90×10^{5}
Liver	1.32×10^{7}	1.24×10^{7}	(e)
Bone Surfaces	6.42×10^{7}	5.91×10^{7}	2.99×10^{6}
Lung	(f)	(f)	(f)

GROUND-PLANE IRRADIATION [REM · SQUARE METER / MICROCURIE] [d]

Organ	Pu-239, -240	Am-241
Effective Dose Equivalent	4.80×10^{-5}	2.99×10^{-3}
Liver	4.53×10^{-6}	1.78×10^{-3}
Bone Surfaces	1.62×10^{-5}	3.69×10^{-3}
Lung	9.78×10^{-6}	2.01×10^{-3}

a. Inhalation and water ingestion dose conversion factors were adapted from DOE/EH-0071 (US88b) and are for a 50-yr dose commitment period and a 1 micrometer (µm) Activity Median Aerodynamic Diameter (AMAD) particle size (VA85). Gastro-Intestinal (GI) absorption fractions and lung clearance classes were chosen to maximize the dose conversion factors.
b. An inhalation rate of 2.66×10^{2} milliliters per second (ml/s) for 1 yr was assumed and incorporated into the dose conversion factor.
c. A water intake rate of 2×10^{3} ml (2.1 quarts) per day for 1 yr was assumed.
d. Ground plane irradiation dose conversion factors were adapted from DOE/EH-0070 (US88a). For Pu-239 and -240, the higher of the factors for the two isotopes was used. A 1-yr exposure period was assumed.
e. The liver receives no significant dose from this pathway.
f. The lung receives no significant dose froim this pathway.

TABLE 3.6-3

Radioactivity Concentrations Used in Dose Calculations for the Rocky Flats Plant in 1989

	Air (µCi/ml)	Water (µCi/ml)			Surface Deposition (µCi/m²)	
Location	Pu-239, -240	Pu-239, -240	Am-241	U-233, -234, -238	Pu-239, -240	Am-241
Maximum Site Boundary	3.0×10^{-18}	1.9×10^{-11}	1.2×10^{-11}	3.6×10^{-9}	3×10^{-2}	6×10^{-3}
Community	3.0×10^{-18}	-	-	-	-	-

TABLE 3.6-4

Fifty-Year Committed Dose Equivalent From One Year of Chronic Intake/Exposure from the Rocky Flats Plant in 1989

Source	Effective Dose Equivalent (mrem)	Liver (mrem)	Bone Surfaces (mrem)	Lung (mrem)
Maximum Site Boundary Location	8.3×10^{-1}	4.8×10^{-1}	1.3×10^{1}	4.4×10^{-2}
Community	1.7×10^{-2}	6.7×10^{-2}	3.1×10^{-1}	3.2×10^{-2}

The source term for inhalation used in this air dose assessment is the maximum annual average plutonium concentration measured in ambient air at any community sampling location (3×10^{-18} µCi/ml [1.1×10^{-7} Bq/m³]). This concentration is the annual average of measured concentrations for the Jefferson County Airport ambient air sampler.

A summary of source terms for the maximum site boundary and community locations is tabulated in Table 3.6-3.

Results

Maximum Site Boundary Dose

Calculation of maximum radiation dose to an individual continuously present at the RFP boundary uses radionuclide concentrations in Table 3.6-3. From these concentrations and dose conversion factors given in Table 3.6-2, a 50-yr *dose commitment of* 8.3×10^{-1} *mrem* (8.3×10^{-3} *mSv*) is calculated as the effective dose equivalent from all pathways. The corresponding bone surface dose is 1.3×10^{1} mrem (1.3×10^{-1} mSv). The DOE interim radiation protection standard for members of the public for prolonged periods of exposure is 100 mrem/yr (1 mSv per yr [mSv/yr]) effective dose equivalent. The maximum site boundary dose in 1989 represents 0.83% of the standard for all pathways for effective dose equivalent.

Maximum Community Dose

Fifty-year dose commitments for community locations in 1989 were 1.7×10^{-2} mrem (1.7×10^{-4} mSv) effective dose equivalent and 3.1×10^{-1} mrem (3.1×10^{-3} mSv) dose equivalent to bone surfaces. Calculated effective dose equivalent for the community location was 0.017% of the DOE interim standard for all pathways.

Eighty-Kilometer Dose Estimates

Dose commitment for all individuals to a distance of 80 km (50 mi) is based on the calculated maximum community dose estimates shown in Table 3.6-4. The estimated committed effective dose equivalent is less than 1 mrem (1×10^{-2} mSv). A level of 1 mrem/yr or less is specified as a *de minimis* (inconsequential) level of exposure in the DOE guide titled, "A Guide to Reducing Radiation Exposure to As Low As Reasonably Achievable (ALARA)" (US80b). The guide further states:

> "Radiation-induced mutations and diseases have not been discovered in populations that are or have been exposed to doses of 100 mrem/year or less. Hence, it is reasonable to suggest that no health effects will be discerned if a population is exposed to an additional 1 percent of the

TABLE 3.6-5

Radionuclide Air Emissions for the Rocky Flats Plant in 1989, for Input to AIRDOS-EPA/RADRISK Computer Codes

Radionuclide (s)	Air Emission Activity (Ci)
Measured Building Emissions:	
H-3	1.77×10^{-1}
Pu-238	2.16×10^{-7}
Pu-239, -240	4.90×10^{-6}
U-233, -234	5.02×10^{-6}
U-238	2.60×10^{-6}
Am-241	1.18×10^{-6}
Estimated Soil Resuspension:	
Pu-241	2.2×10^{-2}
Pu-239, -240	4.4×10^{-3}
Am-241	8.8×10^{-4}

level; i.e., 1 mrem/yr. An annual dose of 1 mrem should be regarded as a level which is clearly *de minimis*."

Based on the *de minimis* concept and maximum community dose estimates, the dose commitment for all individuals in 1989 to 80 km was considered to be inconsequential.

Radiation Dose from Air Pathway Only

EPA-approved methodology (US85) is used to demonstrate compliance with Clean Air Act NESHAP standards for airborne radioactivity emissions. Prior to setting of revised NESHAP standards on December 15, 1989, the EPA-approved standard was based on meteorological/dose modeling of air emissions using the AIRDOS-EPA and RADRISK computer codes. Table 3.6-5 lists the 1989 air emissions activities used as input to the AIRDOS-EPA and RADRISK computer codes. These activities included building air effluent release values for the year as discussed in Section 3.1 and an estimate of resuspension from soil as developed in the "Rocky Flats Plant Site Environmental Impact Statement" (US80a).

Maximum dose equivalents to the public from RFP air emissions in 1989 are summarized in Table 3.6-6. These are results of the AIRDOS-EPA and RADRISK computer modeling.

AIRDOS-EPA and RADRISK models calculated a whole body dose equivalent to the maximally exposed individual of 2.3×10^{-1} mrem (2.3×10^{-3} mSv). The maximum individual organ (bone surfaces) dose was 6.6 mrem (6.6×10^{-2} mSv). These values represented 0.92% of the EPA NESHAP standard for whole body dose equivalent and 8.8% of the standard for an individual organ.

Natural Background Radiation Dose

Effective dose equivalents from RFP may be compared to an average annual effective dose equivalent for the Denver area of about 350 mrem (3.5 mSv) from natural background radiation (NA87b) (Table 3.6-7). Natural background radiation for Denver is higher than shown for the total body in RFP annual reports prior to 1985 and also higher than shown for effective dose equivalent in the 1985 and 1986 annual reports. The level reflects the most recent assessment of natural background radiation exposure of the population of the United States by the NCRP. It includes the significant contribution to effective dose equivalent from inhaled indoor radon, as well as the adoption of the ICRP 30 methodology of radiation dosimetry. Cosmic radiation and external primordial nuclides sources shown in Table 3.6-7 reflect the regional dose levels for the Denver area from Denver's higher elevation and greater concentration of naturally occurring radioactive materials in soil. The internal primordial nuclides source includes the average dose from indoor radon estimated by the NCRP for the entire United States. Investigations are now being conducted to determine whether any regional differences in indoor radon doses exist. Once these studies are completed, the estimates of natural background radiation dose for the Denver area may be modified to reflect indoor radon doses specific to this region.

TABLE 3.6-6

Maximum Air Emission Individual Dose to the Public from the Rocky Flats Plant in 1989[a]

	Dose Equivalent (mrem)		
Organ	From Measured Building Emissions	From Estimated Soil Resuspension	Total Both Sources
Whole Body	1.0×10^{-3}	2.3×10^{-1}	2.3×10^{-1}
Liver	3.1×10^{-3}	1.3	1.3
Bone Surfaces	1.7×10^{-2}	6.5	6.6
Lung	3.0×10^{-3}	4.3×10^{-1}	4.3×10^{-1}

a. Calculated using AIRDOS-EPA/RADRISK computer codes.

TABLE 3.6-7

Estimated Annual Natural Background Radiation Dose for the Denver Metropolitan Area (NA87a)

Source	Effective Dose Equivalent (mrem)
Cosmic Radiation	50
Cosmogenic Nuclides	1
Primordial Nuclides-External	63
Primordial Nuclides-Internal	239
Total for One Year (rounded)	350

4.0

QUALITY ASSURANCE AND QUALITY CONTROL

R. J. CROCKER

The Rocky Flats Non-Weapons Quality Assurance Program establishes policies and guidelines for quality assurance of environmental programs at RFP. This program is based on ANSI/ASME NQA-1, "Quality Assurance Program Requirements for Nuclear Facilities," as implemented through the RFP "Non-Weapons Quality Manual." Quality assurance programs are required under DOE Order 5700.6B, "Quality Assurance/Non-Weapons Quality Assurance."

Quality Assurance/Quality Control (QA/QC) plans have been developed for three primary environmental program areas at RFP: 1) general environmental management and monitoring (Environmental Management), 2) analytical laboratory support (Health, Safety and Environmental Analytical Laboratories), and 3) environmental restoration (Environmental Restoration). Independent and internal audits of *these programs, coupled with control procedures, ensure that* quality assurance and quality control elements exist for a comprehensive environmental program.

Environmental Management (EM)

Objectives of the QA/QC plan for EM are:

- To ensure that current, written charters exist for all environmental program elements. These must ensure that all *applicable requirements are satisfied in a comprehensive,* integrated approach;
- To ensure that current written operating procedures exist for all phases of EM operations and that these procedures are implemented as written;
- To ensure that appropriate approvals are obtained prior to significant program initiations or changes;
- To ensure that equipment used in sample collection and data analysis is appropriate to the assigned function and is operating as required;
- To ensure that accurate documentation exists for all programs, procedures, actions, and audits;
- To ensure that all variances from procedures, equipment use or performance are documented and explained with an assessment; and
- To ensure that appropriate guidelines and standards for environmental monitoring are identified and documentation of compliance is provided on a routine basis to RFP management, DOE, and other state and federal regulatory agencies.

The QA/QC plan for EM establishes administrative control points, delineates responsibilities for specific categories of activities, and provides an information base from which procedures can be developed, updated, and/or implemented. Included are contingency plans for emergency preparedness and documentation to comply with regulations of federal, state, and local agencies. *Quality assurance flow charts and* quality matrices illustrate activity networks and corresponding quality elements of each responsibility area. A complete listing of activities and responsibilities is included in the QA/QC plan.

TABLE 4.0-1

Health, Safety and Environmental Laboratories Interactive Measurement Evaluation and Control System (January - December 1989)

Attribute	Matrix	Method	Sample Range		Normal Sample Range		Annual Relative Error Percent[a]	Range of Relative Error Percent	Total Control Analyses
Pu-239, -240	Water	Alpha Spectral	1.2-35	d/m/l[b]	0-3	d/m/l	-45.4[c]	-100 to +71	51
Am-241	Water	Alpha Spectral	0.7-21	d/m/l	0-3	d/m/l	-30.7[c]	- 98 to +62	52
U-238, -234,	Water	Alpha Spectral	3-90	d/m/l	0-30	d/m/l	-17.5[d]	-100 to +62	53
H-3	Water	Liquid Scintillation	5,000-60,000	d/m/l	0-9,990	d/m/l	-9.8[e]	-43 to -1	44
Pu-239, -240	Effluent Filters	Alpha Spectral	4-120	d/m/l[b]	0-3	d/m/l	-10.8	-96 to +31	101
Am-241	Effluent Filters	Alpha Spectral	3-90	d/m/l	0-4	d/m/l	5.9	-98 to +93	99
U-238, -234,	Effluent Filters	Alpha Spectral	10-300	d/m/l	0-30	d/m/l	-13.3[d]	-30 to +12	118
Be[f]	Effluent Filters	Atomic Absorption	0.3 -10	µg/l[b]	0-5	µg/l	-5.1[g]	-100 to +287	50
Be	Workplace Filters	Atomic Absorption	0.3-10	µg/l	0-20	µg/l	-1.9	-89 to +125	1,079
Pu-239, -240	Ambient Filters	Alpha Spectral	2-45	d/m/l	0-50	d/m/l	-1.5	-100 to +200	52

a. The mean of the ratio of the 12-month differences between observed and standard values to the standard values in percent. This term is inclusive of all random and systematic error in the standards, analytical chemistry, and measurement process for a given nuclide, matrix, and procedure.
b. d/m/l = disintegrations per minute per liter; d/m/f = disintegrations per minute per filter; µg/l = micrograms per filter.
c. Bias is a result of control samples which were not acidified. Field samples have been acidified according to procedure. Control samples will also be acidified starting June 1990.
d. The internal tracer used for uranium is U-236. The U-234 added to the control sample contains 2% U-235 by activity. The energies of U-235 and U-236 are so close they cannot be resolved by alpha spectroscopy. As a result, the U-234 added to the control sampled biases the recovery high and the sample result low. Efforts are underway to use U-232 as a tracer which will eliminate the source of bias discussed, as well as allow quantification of U-235.
e. Bias attributed to -12% error on control standard, error corrected 1/16/90.
f. Analyzed by 881 General Laboratory.
g. Blank correct values only are included.

Health, Safety and Environmental Laboratories (HS&E)

To ensure data reliability, the HS&E QA/QC plan outlines quality control methods used in all phases of laboratory operations. This program includes the following elements:

- Development, evaluation, improvement, modification, and documentation of analytical procedures;
- Scheduled instrument calibration, control charting, and preventive maintenance;
- Participation in interlaboratory quality comparison programs; and
- Intralaboratory quality control programs.

All sample batches analyzed by the HS&E Laboratories Central Receiving Laboratory contain an average of 10% control samples. Controls consist of analytical blanks prepared in-house and standards prepared by the RFP Chemistry Standards Laboratory. An analysis or group of analyses may be rejected and the sample or samples scheduled for reanalysis for one or more of the following reasons:

- Overall chemical recovery of the spike is less than 10% or greater than 105%;
- Analytical blanks in the analysis batch are all out of acceptable range. A statistical test is utilized to reject blank outliers;
- Alpha energy spectrum is not acceptable because of extra and/or unidentified peaks, excess noise in background areas or poor resolution of peaks; or
- The chemist in charge of the laboratory believes there is reason to suspect the analysis.

Any unusual condition affecting the results, noted either during sample collection or analysis, is reported to the appropriate management officials. Table 4.0-1 is a summary of HS&E Laboratories' participation in the RFP Interactive Measurement Evaluation and Control System for 1989. The HS&E Laboratories participate in the EPA Environmental Monitoring Systems Laboratory and the DOE Environmental Measurements Laboratory Crosscheck Programs. Table 4.0-2 summarizes HS&E Laboratories' participation in this program.

Environmental Restoration (ER)

Multi-media monitoring activities at RFP are part of the DOE's ER Program (formerly called the Comprehensive Environmental Assessment and Response Program). The ER Program's QA/QC Plan is one component of the monitoring

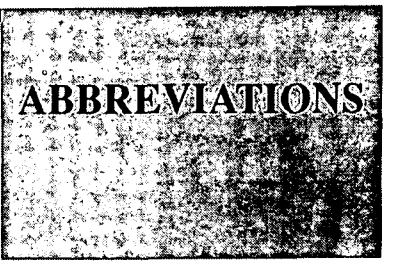
TABLE 4.0-2

Health, Safety and Environmental Laboratories Participation in the EPA Environmental Monitoring Systems Laboratory Crosscheck Program During 1989

Isotope Reported	Matrix	Method	Number of Analyses	Number of Acceptable Analyses[a]	Annual Relative Error Percent[b]	Range of Relative Error Percent
Gross Alpha	Filter	Gas Proportional	2	2	4.9	-6.3 to 11.2
Gross Beta	Filter	Gas Proportional	1	1	-1.1	NA[c]
H-3	Water	Beta Liquid Scintillation	3	3	2.4	-2.9 to 6.8
Co-60	Water	Gamma Spectral	1	1	20.0	NA[c]
Cs-134	Water	Gamma Spectral	2	2	-0.8	-9.3 to 7.7
Cs-137	Water	Gamma Spectral	2	1	18.5	0.7 to 26.6
Cr-51	Water	Gamma Spectral	1	1	11.0	NA[c]
Ru-106	Water	Gamma Spectral	2	2	4.9	3.7 to 6.1
Pu-239	Water	Alpha Spectral	1	1	10.0	NA[c]
U (nat.)	Water	Alpha Spectral	3	3	- 23	-60 to -11

a. "Acceptable analyses" are those analyses for which the observed value was within ± 3 standard deviations of the standard value.
b. The mean of the ratio of the 12-month differences between observed and standard values to standard values in percent. This term is inclusive of all random and systematic error in the standards, analytical chemistry, and measurement process for a given nuclide, matrix, and procedure.
c. NA = Not applicable.

plans for RFP. The monitoring plans consist of five parts: Sampling Plans, Technical Data Management Plan, Health and Safety Plan, QA/QC Plans, and Standard Operating Procedures. Complete programmatic details for ER are detailed in "Quality Assurance Program Plan, Environmental Restoration Program, Rocky Flats Plant," October 1989.



ABBREVIATIONS

Units of Measure

Bq	Becquerels
Bq/l	Becquerels per liter
Bq/m^2	Becquerels per square meter
Bq/m^3	Becquerels per cubic meter
°C	Degree Celsius
Ci	Curies
Ci/g	Curies per gram
cm	Centimeter
d/m/µCi	Disintegrations per minute per microcurie
d/m/pCi	Disintegrations per minute per picocurie
d/m/f	Disintegrations per minute per filter
d/m/l	Disintegrations per minute per liter
dpm/g	Disintegrations per minute per gram
dps	Disintegrations per second
°F	Degree Fahrenheit
ft	Foot
ft^2	Square Feet
ft^3/min	Cubic foot per minute
g	Gram
gal	Gallon
g/cm^2	Grams per square centimeter
g/day	Grams per day
gpm	Gallons per minute
ha	Hectare
hr	Hour
in.	Inch
kg	Kilogram
km	Kilometer
l	Liter
l/d	Liter per disintegration
l/s	Liter per second
lb	Pound
m	Meter
m^2	Square meter
m^3	Cubic meter
m^3/s	Cubic meter per second
mg/cm^2	Milligrams per square centimeter
mg/l	Milligrams per liter
m/km	Meters per kilometer
ml	Milliliter
ml/day	Milliliters per day
ml/s	Milliliter per second
mph	Miles per hour
mrem	Millirem
mrem/day	Millirem per day
mrem/yr	Millirem per year
m/s	Meters per second
m^3/s	Cubic meter per second
mSv	Millisievert
mSv/yr	Millisievert per year
µCi	Microcurie
$µCi/m^2$	Microcurie per square meter
µCi/ml	Microcuries per milliliter
µg	Microgram
µg/f	Micrograms per filter
µg/l	Micrograms per liter
$µg/m^3$	Micrograms per cubic meter
µg/ml	Micrograms per milliliter
pCi	Picocurie
pCi/g	Picocuries per gram
pCi/l	Picocuries per liter
ppb	Parts per billion
ppm	Parts per million
pt	Pint
%	Percent
rem	Roentgen equivalent man
rem/yr	Roentgen equivalent man per year
Sv	Sievert

ABBREVIATIONS

CONTINUED

Chemical Elements and Compounds

Am	Americium
Ba	Barium
Be	Beryllium
Ca	Calcium
CCl_4	Carbon Tetrachloride
Cl	Chlorine
Cm	Curium
CO	Carbon Monoxide
Co	Cobolt
Cr	Chromium
Cs	Cesium
Fe	Iron
H-3	Hydrogen-3 (Also called "Tritium")
Mg	Magnesium
Mn	Manganese
N	Nitrogen
Na	Sodium
NO_2	Nitrogen Dioxide
NO_3	Nitrate
O_3	Ozone
Pb	Lead
PCB	Polychlorinated Biphenyls
PCE	Tetrachloroethene
Pu	Plutonium
Ru	Ruthenium
Se	Selenium
SO_2	Sulfur Dioxide
SO_4	Sulfate
Sr	Strontium
TCA	1,1,1 - Trichloroethane
TCE	Trichloroethene
Tm	Thulium
U	Uranium
Zn	Zinc

Symbols

β	Beta
α	Alpha

ACRONYMS

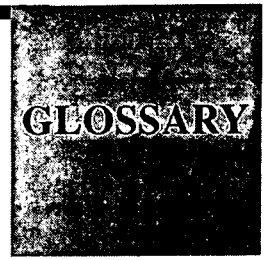
ACRONYMS

ACNFS	Advisory Committee on Nuclear Facility Safety (Ahearne Committee)
ADM	Action Description Memorandum
AEC	Atomic Energy Commission
APEN	Air Pollution Emission Notice
ARAR	Applicable or Relevant and Appropriate Requirements
BOD_5	Biochemical Oxygen Demand, 5-day incubation period
CDH	Colorado Department of Health
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CWQCC	Colorado Water Quality Control Commission
DCG	Derived Concentration Guide
DOE	Department of Energy
EA	Environmental Assessment
EC	Environmental Checklist
EIS	Environmental Impact Statement
EM	Environmental Management
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
ER	Environmental Restoration
ERDA	Energy Research and Development Administration
FYP	Five-Year Plan
HEPA	High Efficiency Particulate Air
HS&E Labs	Health, Safety and Environmental Laboratories
ICRP	International Commission on Radiological Protection
MDA	Minimum Detectable Amount
NA	Not Applicable
NAAQS	National Ambient Air Quality Standards
NCC	NEPA Compliance Committee
NCRP	National Council on Radiation Protection and Measurements
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NOID	Notice of Intent to Deny
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	Nuclear Regulatory Commission
PM-10	Particulate Matter - 10
QA/QC	Quality Assurance/Quality Control

ACRONYMS

CONTINUED

RCG	Radioactivity Concentration Guides
RCRA	Resource Conservation and Recovery Act
RFP	Rocky Flats Plant
SAAM	Selective Alpha Air Monitor
SARA	Superfund Amendment and Reauthorization Act
SPCC/BMP	Spill Prevention Control and Countermeasures/Best Management Practices
SSP	Site-Specific Plan
STP	Sewage Treatment Plant
SU	Standard Units
SWMU	Solid Waste Management Unit
TDS	Total Dissolved Solids
TLD	Thermoluminescent dosimeter
TRU	Transuranic
TSCA	Toxic Substances Control Act
TSP	Total Suspended Particulates
VOC	Volatile Organic Compound



GLOSSARY

activity. See radioactivity.

air pollutant. Any fume, smoke, particulate matter, vapor, gas, or combination thereof which is emitted into or otherwise enters the atmosphere, including, but not limited to, any physical, chemical, biological, radioactive (including source material, special nuclear material, and by-product materials) substance or material, but does not include water vapor or steam condensate.

alpha particle. A positively charged particle emitted from the nucleus of an atom having the same charge and mass as that of a helium nucleus (2 protons, 2 neutrons).

atom. Smallest particle of an element capable of entering into a chemical reaction.

beta particle. A negatively charged particle emitted from the nucleus of an atom having a mass and charge equal to that of an electron.

concentration. The amount of a specified substance or amount of radioactivity in a given volume or mass.

contamination. The deposition of unwanted radioactive or hazardous material on the surfaces of structures, areas, objects, or personnel.

cosmic radiation. Radiation of many types with very high energies, originating outside the earth's atmosphere. Cosmic radiation is one source contributing to natural background radiation.

curie (Ci). The traditional unit for measurement of radioactivity based on the rate of radioactive disintegration. One curie is defined as 3.7×10^{10} (37 billion) disintegrations per second. Several fractions and multiples of the curie are in common usage:

millicurie (mCi). 10^{-3} Ci, one-thousandth of a curie; 3.7×10^{7} disintegrations per second.

microcurie (μCi). 10^{-6} Ci, one-millionth of a curie; 3.7×10^{4} disintegrations per second.

nanocurie (nCi). 10^{-9} Ci, one-billionth of a curie; 37 disintegrations per second.

picocurie (pCi). 10^{-12} Ci, one-trillionth of a curie; 3.7×10^{-2} disintegrations per second.

femtocurie (fCi). 10^{-15} Ci, one-quadrillionth of a curie; 3.7×10^{-5} disintegrations per second.

attocurie (aCi). 10^{-18} Ci, one-quintillionth of a curie; 3.7×10^{-8} disintegrations per second.

decay, radioactive. The spontaneous transformation of one radionuclide into a different radioactive or nonradioactive nuclide, or into a different energy state of the same radionuclide.

Derived Concentration Guide (DCG). Secondary radioactivity in air and water concentration guides used for comparison to measured radioactivity concentrations. Calculation of DCG assumes that the exposed individual inhales 8,400 cubic meters of air per year or ingests 730 liters of water per year at the specified radioactivity DCG with a resulting radiation dose of 0.1 rem (100 mrem) effective dose equivalent.

disintegration, nuclear. A spontaneous nuclear transformation (radioactivity) characterized by the emission of energy and/or mass from the nucleus of an atom.

dose, absorbed. The amount of energy deposited by radiation in a given mass of material. The unit of absorbed dose is the rad or the gray. (1 gray = 100 rad).

dose commitment. The total radiation dose projected to be received from an exposure to radiation or intake of radioactive material throughout the specified remaining lifetime of an individual. In theoretical calculations, this specified lifetime is usually assumed to be 50 yrs.

dose equivalent. A modification to absorbed dose which expresses the biological effects of all types of radiation (e.g., alpha, beta, gamma) on a common scale. The unit of dose equivalent is the rem or the sievert (1 sievert = 100 rem).

exposure. A measure of the ionization produced in air by X-ray or gamma + radiation. The special unit of exposure is the roentgen (R).

gamma ray. High-energy, short-wavelength electromagnetic radiation emitted from the nucleus of an atom. Gamma radiation frequently accompanies the emission of alpha or beta particles. Gamma rays are identical to X-rays except for the source of the emission.

half-life, radioactive. The time required for a given amount of a radionuclide to lose half of its activity by radioactive decay. Each radionuclide has a unique half-life.

isotopes. Forms of an element having the same number of protons in their nuclei and differing in the number of neutrons.

minimum detectable concentration (MDC). The smallest amount or concentration of a radioelement that can be distinguished in a sample by a given measurement system in a preselected counting time at a given confidence level.

natural radiation. Radiation arising from cosmic sources and from naturally occurring radionuclides (such as radon) present in the human environment.

outfall. The place where a storm sewer or effluent line discharges to the environment.

part per billion (ppb). Concentration unit approximately equivalent to µg/l.

part per million (ppm). Concentration unit approximately equivalent to mg/l.

pathway. Potential route for exposure to radioactive or hazardous materials.

person-rem. The traditional unit of collective dose to a population group. For example, a dose of one rem to 10 individuals results in a collective dose of 10 person-rem.

quality factor. The factor by which the absorbed dose (in rad or gray) is multiplied to obtain the dose equivalent (in rem or sievert). The dose equivalent is a unit that expresses, on a common scale for all ionizing radiation, the biological damage to exposed persons. It is used because some types of radiation, such as alpha particles, are more biologically damaging than others.

rad. A traditional unit of absorbed dose. The International System of Units (SI) unit of absorbed dose is the gray (1 gray = 100 rads).

radioactivity. The spontaneous emission of radiation, generally alpha or beta particles, often accompanied by gamma rays, from the unstable nucleus of an atom.

radionuclide. An atom having an unstable ratio of neutrons to protons so that it will tend toward stability by undergoing radioactive decay. A radioactive nuclide.

rem. The traditional unit of dose equivalent. Dose equivalent is frequently reported in units of millirem (mrem) which is one-thousandth of a rem. The International System of Units (SI) unit of dose equivalent is the sievert (1 sievert = 100 rem).

Roentgen (R). The traditional unit of exposure to X-ray or gamma radiation based on the ionization in air caused by the radiation. One Roentgen is equal to 2.58 X 10^{-4} coulombs per kilogram of air. A common expression of radiation exposure is the milliRoentgen (1R = 1000 mR).

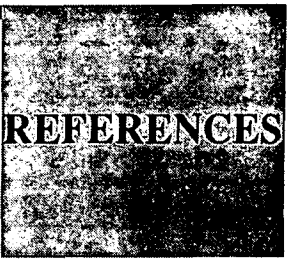
sievert (Sv). International System of Units (SI) unit for radiation dose, 1 Sv = 100 rem.

thermoluminescent dosimeter (TLD). A device used to measure external sources (i.e., outside the body) of penetrating radiation such as X-rays or gamma rays.

tritium (H-3). The hydrogen isotope having one proton and two neutrons in the nucleus. It is radioactive and emits a low energy beta particle (0.0186 MeV max).

uncontrolled area. Any area to which access is not controlled for the purpose of protecting individuals from exposure to radiation and radioactive materials. The area beyond the boundary of the RFP is an uncontrolled area.

worldwide fallout. Radioactive debris from atmospheric weapons tests that is either airborne and cycling around the earth or has been deposited on the earth's surface.



REFERENCES

CO73 Colorado Department of Health, State of Colorado, Division of Occupational and Radiological Health, Denver, Colorado, 1973.

CO77 Colorado Department of Health, State of Colorado, Water Quality Control Division, "Primary Drinking Water Regulations Handbook," Denver, Colorado, effective December 15, 1977.

CO78 Colorado Department of Health, "Rules and Regulations Pertaining to Radiation Control," Part IV, 1978, Denver, Colorado, as revised through December 30, 1985.

CO81 Colorado Department of Health, State of Colorado, Water Quality Control Division, "Colorado Primary Drinking Water Regulations," Denver, Colorado, effective October 30, 1981.

CO89 Colorado Water Quality Control Commission, "Classifications and Numeric Standards for South Platte River Basin; Republican River Basin; Smokey Hill River Basin," 3.8.0 (5CCR 1002-8), Denver, Colorado, July 1989.

DR89 Denver Regional Council of Governments, "DRCOG Makes 1989 Estimates of Metro Population and Households," Denver, Colorado, September 1989.

EG90a EG&G Rocky Flats, Inc., "1989 Annual RCRA Ground-Water Monitoring Report for Regulated Units at Rocky Flats Plant," Golden, Colorado, March 1990.

EG90b EG&G Rocky Flats, Inc., "EG&G's Response to the Assessment of Environmental Conditions at the Rocky Flats Plant - Revision B," Golden, Colorado, August 1989/March 2, 1990.

EG90c EG&G Rocky Flats, Inc., "Rocky Flats Plant, Fiscal Year 1990 Site-Specific Plan," Golden, Colorado, February 1990.

HA72 Harley, J. H., Ed., "Procedures Manual and Supplements 1-4," Health and Safety Laboratory, U. S. Atomic Energy Commission, Washington, DC, 1972.

HA83 Hach Co., "DPD Method for Chlorine," Loveland, Colorado, 1983.

HE85 Health Physics Society Subcommittee WG2.5, "Performance Criteria for Radiobioassay," draft ANSI N13.30, November 1985.

IN75 International Commission on Radiological Protection (ICRP), "Reference Man," ICRP Publication 23, Pergamon Press, New York, New York, 1975.

IN79 International Commission on Radiological Protection (ICRP), "Limits for Intakes of Radionuclides by Workers," ICRP Publication 30, Parts 1 through 4 (including supplements and addenda), Pergamon Press, New York, New York, 1979-1988.

IN86 International Commission on Radiological Protection (ICRP), "The Metabolism of Plutonium and Related Elements," ICRP Publication 48, Pergamon Press, New York, New York, 1986.

KO81 D. C. Kocher, "Dose-Rate Conversion Factors for External Exposure to Photons and Electrons," NUREG/CR-1918, ORNL/NUREG-79, Oak Ridge National Laboratory, Oak Ridge, Tennessee, 1981.

KO83 D. C. Kocher, "Dose-Rate Conversion Factors for External Exposure to Photons and Electrons," Health Physics, 45, 665, Oak Ridge National Laboratory, Oak Ridge, Tennessee, 1983.

NA87a National Council on Radiation Protection and Measurements, "Exposure of the Population in the United States and Canada from Natural Background Radiation," NCRP Report No. 94, Bethesda, Maryland, December 30, 1987.

NA87b National Council on Radiation Protection and Measurements, "Ionizing Radiation Exposure of the Population of the United States," NCRP Report No.93, Bethesda, Maryland, September 1, 1987.

RI89a Rockwell International, "1988 Annual RCRA Ground-Water Monitoring Report for Regulated Units at Rocky Flats Plant," Golden, Colorado, March 1989.

RI89b Rockwell International, "Background Hydrogeochemical Characterization & Monitoring Plan," Golden, Colorado, January 1989.

RI89c Rockwell International, "Proposed Interim Measures/Interim Remedial Action Plan and Decision Document, 903 Pad, Mound, and East Trenches Area," Golden, Colorado, December 1989.

RI89d Rockwell International, "Draft Phase II RI/FS Work Plan, Rocky Flats Plant, 903 Pad, Mound, and East Trenches Areas, Operable Unit No. 2," Golden, Colorado, December 1989.

RI89e Rockwell International, "Background Geochemical Characterization Report," Golden, Colorado, December 1989.

RI89f Rockwell International, "Interim Remedial Action Plan for 881 Hillside Area," Golden, Colorado, August 1989.

RI89g Rockwell International, "Catalogue of Monitoring Activities at Rocky Flats," Golden, Colorado, April 1989.

RI89h Rockwell International, "Rocky Flats Plant, Environmental Restoration/Waste Management, Five-Year Plan FY89," Golden, Colorado, August 1989.

RI90 Rockwell International, "Draft Phase III RI/FS Work Plan, Rocky Flats Plant, 881 Hillside Area, Operable Unit No. 1," Golden, Colorado, January 1990.

SC82 Schleicher & Schuell, Publication No. 500, "Innovative Products for Separation Science," March 1982.

US70 U. S. Atomic Energy Commission, "Plutonium in the Soil Around the Rocky Flats Plant, Health and Safety Laboratory," HASL-235, Washington, D.C., August 1, 1970.

US76a U. S. Environmental Protection Agency, "Drinking Water Regulations, Radionuclides, "Federal Register, 41, No. 133, pp. 38402-09, Washington, D.C., July 9, 1976.

US76b U. S. Environmental Protection Agency, "The Quality Assurance Handbook for Air Pollution Measurements Systems, Vol. I," "Principles," EPA-600/9-76-005, March 1976, Vol. II, "Ambient Air Specific Methods," EPA-600/4-77-027a, Research Triangle Park, North Carolina, May 1977.

US77 USEPA, "Proposed Guidance on Date Limits for Persons Exposed to Transuranium Elements in General Environment," Federal Register Notice, USEPA, Washington, D.C., October 1977.

US80a U. S. Department of Energy, "Environmental Impact Statement," Rocky Flats Plant Site, DOE/EIS-0064, Washington, D.C., April 1980.

US80b U. S. Department of Energy, "A Guide to Reducing Radiation Exposure to As Low As Reasonably Achievable (ALARA)," DOE/EV/1830-T5k, Washington, D.C., April 1980.

US81a U. S. Department of Energy, "Standards for Radiation Protection," DOE Order 5480.1A, Chapter XI, Washington, D.C., August 13, 1981.

US81b U. S. Environmental Protection Agency, "National Primary and Secondary Ambient Air Quality Standards," 40 CFR Part 50, Subchapter C - Air Programs, Washington, D.C., 1981.

US83 U. S. Congress, "Clean Air Act," Sects. 112 and 301(a), as amended in 1983 (42 U.S.C. 7412, 7601a), Washington, D.C., 1983.

US84a U. S. Environmental Protection Agency, Region VIII, NPDES Permit CO-0001333, "Authorization to Discharge under the National Pollutant Discharge Elimination System," Denver, Colorado, December 26, 1984.

US85 U. S. Environmental Protection Agency, "National Emission Standards for Radionuclide Emissions from Department of Energy (DOE) Facilities," U. S. Code of Federal Regulations, Title 40, Part 61 (40 CFR 61), Subpart H, February 6, 1985.

US87a U. S. Environmental Protection Agency, "Revisions to the National Ambient Air Quality Standards for Particulate Matter," Federal Register, 60, No. 126, July 1, 1987, p. 24634.

US87b U. S. Environmental Protection Agency, "Environmental and Monitoring and Support Laboratory, Methods for Chemical Analysis of Water and Wastes," EPA-600/4-87-020, Cincinnati, Ohio, 1987.

US88a U. S. Department of Energy, "External Dose-Rate Conversion Factors for Calculation of Dose to the Public," DOE/EH-0070, Washington, D.C., July 1988.

US88b U. S. Department of Energy, "Internal Dose Conversion Factors for Calculation of Dose to the Public," DOE/EH-0071, Washington, D.C., July 1988.

US89a U.S. Department of Energy, "Assessment of Environmental Conditions at the Rocky Flats Plant," Golden, Colorado, August 1989.

US89b U. S. Environmental Protection Agency, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy (DOE) Facilities," U. S. Code of Federal Regulations, Title 40, Part 61 (40 CFR 61), Subpart H, Washington, D.C., December 15, 1989.

VA85 Vaughan, W. A., Assistant Secretary, "Radiation Standards for Protection of the Public in the Vicinity of DOE Facilities," DOE memorandum from Environment, Safety, and Health, U. S. Department of Energy, Washington, D.C., August 5, 1985.

WI82 Williams, W. F., "Health, Safety and Environmental Laboratories Procedures and Practices Manual," RFP-HS&EL-82, Rockwell International, Rocky Flats Plant, Golden, Colorado, 1982.

ENVIRONMENTAL REPORTS FOR THE ROCKY FLATS PLANT

APPENDIX A

Regulatory Report[a]	Agency[b]	Frequency
Air Compliance Report (40 CFR 61.94)	EPA	Annual
Effluent Information System/ Onsite Discharge Information System	DOE	Annual
Environmental Protection Implementation Plan	DOE	Annual
Emergency and Hazardous Chemical Inventory Forms	c	Annual
Toxic Chemical Release Inventory	EPA	Annual
National Pollution Discharge Elimination System/ Discharge Monitoring Report	EPA	Monthly/Annual
Polychlorinated Biphenyls (PCB) Inventory	EPA	Annual
Resource Conservation and Recovery Act Groundwater Monitoring Report	EPA/CDH	Annual
Rocky Flats Environmental Monitoring Report	DOE/EPA/CDH/ County/City	Monthly
Rocky Flats Plant Site Environmental Report	DOE	Annual

a. Reports on major environmental programs prepared on a periodic basis.
b. EPA - Environmental Protection Agency
DOE - Department of Energy
CDH - Colorado Department of Health
County - Jefferson
Cities - Arvada, Broomfield, Westminster, Denver, Boulder, Northglenn, Fort Collins.
c. Colorado Emergency Planning Commission
Jefferson County Emergency Planning Committee
Boulder County Emergency Planning Committee
Rocky Flats Fire Department

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APPENDIX B

METEOROLOGY AND CLIMATOLOGY

W. S. BUSBY

Meteorological data were collected at RFP from instrumentation on a 61-m (200-ft) tower located in the west buffer zone (Figure B-1). Results are summarized as annual percent frequency of wind directions in Table B-1 and Figure B-2 and represent 94% data recovery. Compass point designations (Table B-1) indicate true bearing when facing against the wind as do wind rose vectors (Figure B-2). Results showed a predominance of northwesterly winds and low frequency of easterly winds greater than 7 meters per second (m/s) (15.6 miles per hour [mph]). These results are typical for RFP.

Mean temperature for 1989 was 8.7°C (47.7°F). Maximum temperature was 31.9°C (89.4°F) on July 8th and minimum temperature was -29.4°C (-20.9°F) on February 5th. RFP recorded 32.16 cm (12.66 in) of precipitation in 1989. Maximum precipitation for a 15-minute period was 0.69 cm (0.27 in) on August 6th. Highest wind speed was 39.93 m/s (89.32 mph) on March 14th and mean wind speed for 1989 was 4.16 m/s (9.31 mph).

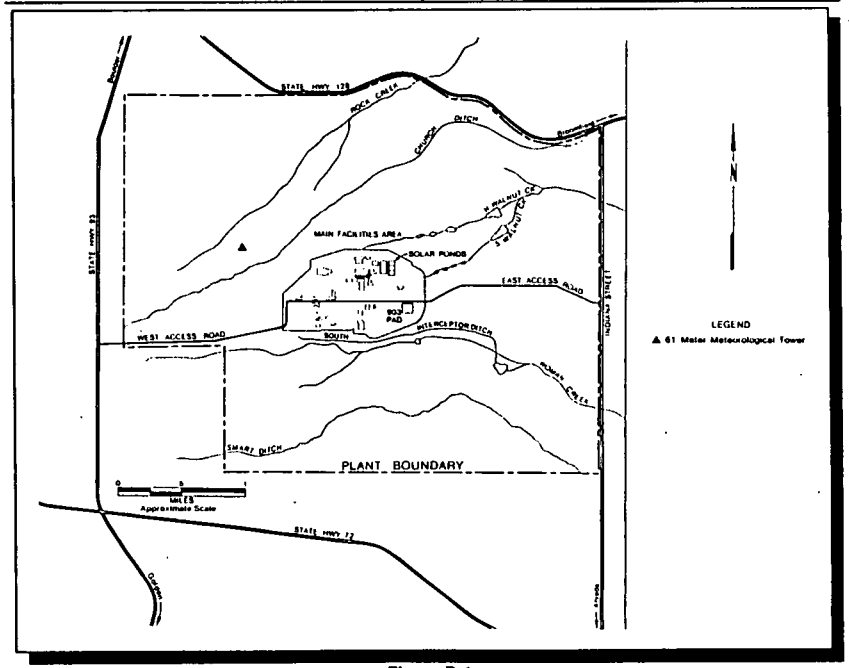

Figure B-1

TABLE B-1

Percent Wind Direction by Four Wind-Speed Classes at the Rocky Flats Plant in 1989

(Fifteen-Minute Averages-1989)

	Calm	1-3 (m/s)	3-7 (m/s)	7-15 (m/s)	>15 (m/s)	Total
-	5.22	-	-	-	-	5.22
N	-	2.66	4.32	0.63	0.00	7.61
NNE	-	2.61	2.79	0.21	0.01	5.62
NE	-	2.28	1.59	0.06	0.00	3.93
ENE	-	1.77	1.08	0.01	0.00	2.86
E	-	1.45	0.82	0.02	0.00	2.29
ESE	-	1.45	0.79	0.02	0.00	2.26
SE	-	1.63	1.63	0.13	0.00	3.39
SSE	-	2.13	2.71	0.19	0.00	5.03
S	-	2.05	3.01	0.24	0.00	5.30
SSW	-	2.22	2.87	0.24	0.00	5.33
SW	-	2.08	2.39	0.16	0.00	4.63
WSW	-	2.18	4.62	0.43	0.00	7.23
W	-	2.71	3.72	1.42	0.25	8.10
WNW	-	2.96	3.83	4.36	0.50	11.65
NW	-	2.98	4.74	3.06	0.11	10.89
NNW	-	2.88	4.59	0.82	0.01	8.30
TOTALS	5.22	36.04	45.50	12.00	0.88	99.64

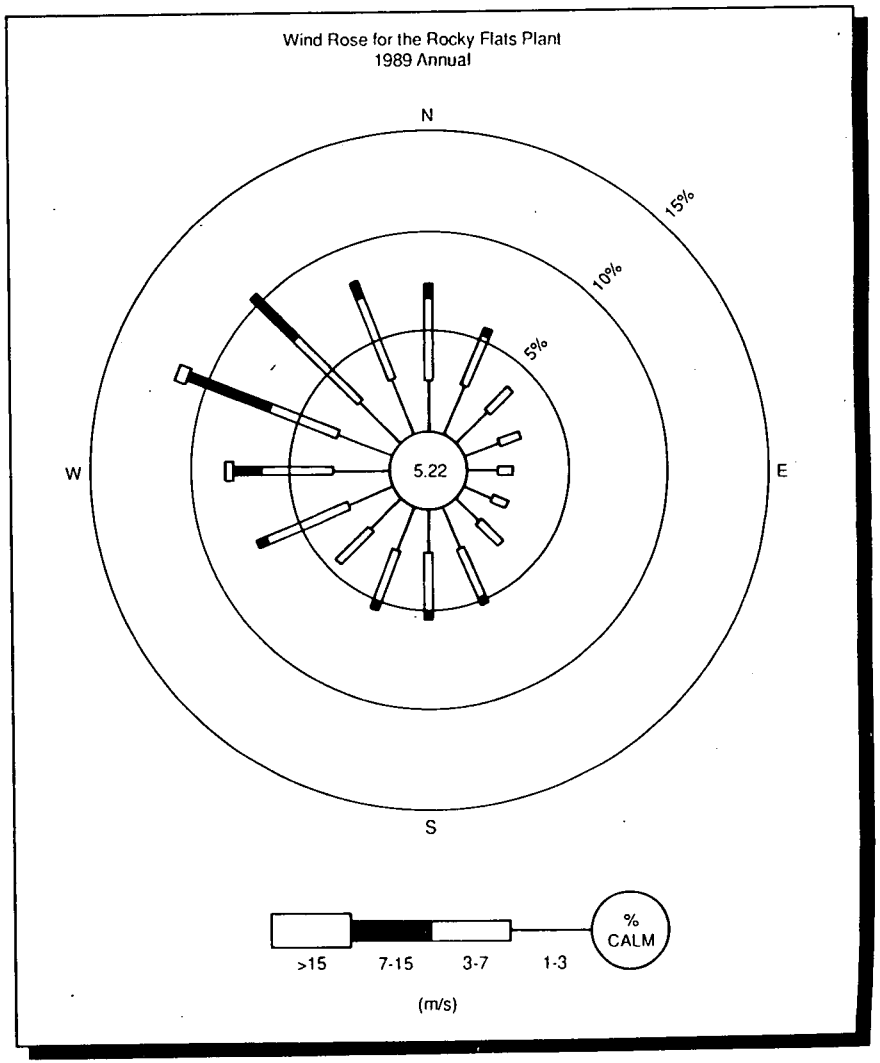

Figure B-2

PERSPECTIVE ON RADIATION

APPENDIX C

N. M. DAUGHERTY

Introduction

Radioactive materials and radiation-producing equipment are handled and operated at RFP. Environmental monitoring programs include monitoring for potential exposures to the public from RFP-related radiation sources. This "Perspective on Radiation" is provided to acquaint the reader with basic concepts of radiation and assist in the understanding and interpretation of the monitoring information and radiation dose assessment.

Further discussion on sources of ionizing radiation can be found in Report No. 93 of the National Council on Radiation Protection and Measurements, "Ionizing Radiation Exposure of the Population of the United States" (NA87b), from which much of the information in this section was derived.

Ionizing Radiation

Many kinds of radiation exist in our environment. Visible light and heat radiating from a warm object are examples. Radiation from radioactive materials and radiation-producing equipment is called ionizing radiation. Ionizing radiation has sufficient energy to separate electrons from atoms of material. This separation is called ionization. When ionizing radiation is absorbed in living tissues, it can cause damage from the ionization process. Consequently, protective measures may be required to minimize the amount of ionizing radiation to which a person might be exposed.

Types of Radiation

Common types of ionizing radiation include alpha, beta, gamma, X-ray, and neutron radiation. While all types can produce ionization, they have other, differing properties. One important property is their ability to penetrate or pass through materials. Alpha radiation penetrates poorly; a piece of paper or outer skin tissue can stop it. Beta radiation has low to moderate penetrating ability. Gamma, X-ray, and neutron radiation usually has much greater penetrating ability. Radiation produced by medical X-ray machines, for example, is able to pass through a human body.

Production of Radiation

Ionizing radiation is produced by radioactive materials and radiation-producing equipment. Radiation-producing equipment includes X-ray machines and linear accelerators. Electrical power must be applied to this equipment to produce radiation. In contrast, radioactive materials will continue to emit ionizing radiation until they have undergone radioactive decay to non radioactive, stable states. The time required for a material to reach this stable state is dependent upon a material's radioactive half-life. Half-life is the amount of time required for one-half of the atoms of a radioactive material to experience radioactive decay. Half-life is unique and unchanging for a specific radionuclide. Half-lives for different radionuclides may vary from seconds to billions of years.

Radiation Dose

The biological effect of ionizing radiation is called radiation dose. The radiation can be from a penetrating radiation source located outside of the body (external radiation) or from radioactive materials taken into the body (internal radiation). In the United States, radiation dose is measured in the unit called the rem or millirem (1 rem = 1000 millirem). The comparable International Standard unit of radiation dose is the sievert (1Sv = 100 rem). A rem is a unit of biological dose that expresses biological damage on a common scale. The effective dose equivalent is a means of calculating radiation dose. Effective dose equivalent takes into account the total health risk estimated for cancer mortality and serious genetic defects from radiation exposure regardless of which body tissues receive the dose or the sources or types of ionizing radiation producing the dose.

Sources of Radiation

All living things are exposed to naturally occuring ionizing radiation. However, since the discovery of radiation and radioactive materials at the beginning of this century, we can significantly increase the amount of radiation we are exposed to through use of artificially produced or enhanced sources of radiation.

Natural Sources

Naturally occurring sources are the greatest contributor to radiation exposures for the U. S. public. Sources of natural background radiation include cosmic radiation from space and secondary radioactive materials (cosmogenic nuclides) created when cosmic radiation enters our atmosphere. Another source is naturally occurring radioactive materials originating from the earth's crust, referred to as primordial nuclides. These materials may contribute to radiation exposure when located outside the body or when taken into the body through inhalation or ingestion. Radon, for example, a radioactive gas derived from uranium, is an important contributor to internal radiation exposure as a result of inhalation inside of buildings.

Different living situations can result in more or less exposure to naturally occurring ionizing radiation. Cosmic radiation exposure can increase as altitude increases because less atmosphere exists to shield against the radiation. Some geographical areas have higher concentrations of primordial nuclides such as uranium and thorium. Because the Denver area is located at a relatively high altitude and also has higher concentrations of uranium and thorium in rocks and soil, naturally occurring radiation levels are higher than those in many other regions in the country.

Annual, naturally occurring effective dose equivalent to a typical resident of the Denver metropolitan area is given in Section 3.6. The total for this area, based on current published reports, is about 350 mrem/yr. This estimate may increase as the Denver regional difference in indoor radon concentration is determined. By comparison, the estimated total average effective dose equivalent for a member of the U. S. population from natural sources is about 300 mrem/yr.

Medical Sources

Ionizing radiation is used in medicine for diagnosis and treatment of many medical conditions. This radiation can be produced by equipment such as X-ray machines or linear accelerators, or it can originate from radioactive materials incorporated into pharmaceuticals. Medical diagnosis and treatment account for the largest radiation doses to the U. S. public from artificially produced sources of radiation. The average effective dose equivalent to a member of the U. S. population from medical sources is about 50 mrem/yr. However, individual doses from this source vary widely, with some people receiving little or none and others receiving much more than the average in any particular year.

Consumer Products Sources

Some consumer products, including tobacco, smoke detectors, and television sets, have ionizing radiation associated with them. Consumer products are the second largest contributor to radiation dose to the U.S. population from artificially produced or enhanced sources. The radiation may or may not be intentional and necessary for the functioning of the product. Ionization smoke detectors and X-ray baggage inspection systems at airports require ionizing radiation to perform their functions. Tobacco products, fuels such as coal, and television receivers have radiation associated with them even though it is not necessary for their use.

Other Sources

Naturally occurring, medical, and consumer product sources contribute over 99% of the average radiation dose that a member of the U. S. population receives each year (Figure C-1). Other sources include occupational exposures, residual fallout from past atmospheric weapons testing, the nuclear fuel cycle, and miscellaneous sources. Combined, these other sources contribute less than 1% of the average radiation dose to a member of the U. S. population.

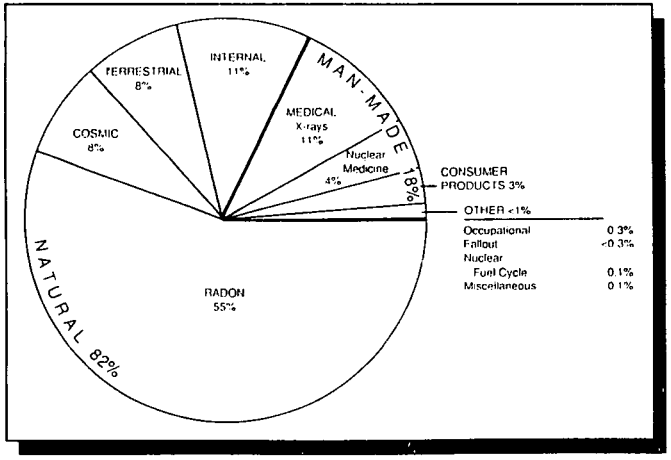

Figure C-1

APPLICABLE GUIDES AND STANDARDS

APPENDIX D

Rocky Flats Plant environmental monitoring programs evaluate plant compliance with applicable guides, limits, and standards. Guide values and standards for radionuclides in ambient air and waterborne effluents have been adopted by the Department of Energy, the Colorado Department of Health, the Colorado Water Quality Control Commission (water only), and by the Environmental Protection Agency (for the air pathway only) (VA85, CO78, US85, CO89). Many of the guides are based on recommendations published by the International Commission on Radiological Protection (ICRP) and the National Council on Radiation Protection and Measurements (NCRP).

Air Standards

Effluent Air

Air effluent limits are established under the National Emission Standards for Hazardous Air Pollutants. Radioactivity emissions are promulgated by EPA and are listed in Table D-1 (see "Air Pathway Only"). Non-radioactive but otherwise hazardous materials emissions are regulated by the State of Colorado under Colorado Air Quality Control Regulation #8.

TABLE D-1

Radiation Protection Standards for the Public for Department of Energy Facilities (VA85)

	EFFECTIVE DOSE EQUIVALENT (mrem/year)
FROM ALL PATHWAYS:	
Occasional Exposures	500
Prolonged Exposures (> 5 years)	100
	DOSE EQUIVALENT (mrem/year)
Individual Organ	5,000
	DOSE EQUIVALENT (mrem/year)
AIR PATHWAY ONLY:	
Prior to Dec. 15, 1989 (US85):	
Whole Body	25
Any Organ	75
	EFFECTIVE DOSE EQUIVALENT (mrem/year)
As of Dec. 15, 1989 (US89b):	10

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TABLE D-2

National Ambient Air Quality Standards (NAAQS) for Particulates in 1989

NAAQS Averaging Time	Concentration
Primary:	
Annual Arithmetic Mean	50 µg/m^3
24-hr Average	150 µg/m^3
Annual Geometric Mean[d]:	
Primary[a]	260 µg/m^3
Secondary[b]	60 µg/m^3
24-hr	
Primary[a,c]	260 µg/m^3
Secondary[b,c]	150 µg/m^3

a. Primary NAAQS are intended to protect public health.
b. Secondary NAAQS are intended to protect public welfare.
c. Not to be exceeded more than once per year.
d. TSP no longer used for determining compliance with NAAQS. Sampling and reporting continues for comparison purposes and general interest.

Respective to hazardous air pollutants at RFP, this regulation sets a limit for beryllium of 10 g per stationary source in a 24-hr period.

Ambient Air

Ambient air data for nonradioactive particulates have been collected historically at Rocky Flats for comparison to criteria pollutants listed under the EPA National Ambient Air Quality Standards, established by the Clean Air Act (US81b) (Table D-2). Instrumentation and methodology follow requirements established by EPA in the "Quality Assurance Handbook for Air Pollution Measurement Systems" (US76b).

Ambient air data for radioactive particulates are compared against Derived Concentration Guides given in Table D-3. A further explanation of DCG standards is given in the Radiological Dose Standards section.

Water Standards

DCGs for surface water effluents are given in Table D-3. A further explanation of DCG standards is given Radiological Dose Standards section.

Surface Water Effluent

National Pollution Discharge Elimination System (NPDES). The NPDES permit sets limits for non radioactive pollutants in effluent water from federal facilities (Table D-4). The RFP NPDES permit, which the EPA reissued to DOE in 1984 and administratively extended in 1989, established effluent limitations for seven discharge points of which Ponds A-3, A-4, B-5, and C-2 discharge into drainages leading off of RFP property.

Colorado Water Quality Control Commission Temporary Surface Water Standards. In July 1989, CWQCC adopted temporary water quality standards for Walnut Creek and Woman Creek. Both creeks receive surface water drainage from RFP. Limits were set for organic and inorganic chemicals, metals, radionuclides, and certain physical and biological parameters (Table D-5a through D-5e).

Drinking Water

In 1976, the EPA promulgated regulations for radionuclides in drinking water (US76a). These regulations were effective on June 24, 1977, along with primary drinking water regulations for microbiological, chemical, and physical contaminants. The intent of the Safe Drinking Water Act was to ensure that each state has primary responsibility for

Table D-3

DOE Derived Concentration Guides for Radioactive Materials

Parameter	Applicable Guides and Standards	Reference
Airborne Effluents		
Plutonium-239, -240	NA	NA
Uranium-233, -234, -238	NA	NA
Tritium (H-3)	NA	NA
Ambient Air		
Plutonium-239, -240	20.0 X 10^{-15} µCi/ml	Calculated[a]
Waterborne Effluents Radioactive		
Plutonium-239, -240	30 x 10^{-9} µCi/ml	Calculated[a]
Uranium-233, -234, -238	500 x 10^{-9} µCi/ml	Calculated[a]
Americium-241	30 x 10^{-9} µCi/ml	Calculated[a]
Tritium (H-3)	2,000,000 x 10^{-9} µCi/ml	Calculated[a]

a. Derived Concentration Guides (DCGs) calculated using DOE dose limit of 100 mrem/yr to members of the public from all pathways, dose conversion factors and methodology given in DOE/EH-0071, and intake rates of 8,400 m^3/yr for air and 730 l/yr for water.

maintaining drinking water quality. To comply with these requirements, the CDH modified existing state drinking water standards to include radionuclides (CO77, CO81). Two of the community drinking water standards are of interest in this report. The state standard for gross-alpha activity (including radium-226 but excluding radon and uranium) in community water systems is a maximum of 15 pCi/l or 15 X 10^{-9} µCi/ml (5.6 x 10^{-1} Bq/l). Americium and plutonium, which are alpha-emitting radionuclides, are included in this limit. The limit for tritium in drinking water is 20,000 pCi/l or 20,000 x 10^{-9} µCi/ml (740 Bq/l).

Soils Standards

The standard for plutonium adopted by CDH in 1973 is 2.0 disintegrations per minute per gram (dpm/g) (0.9 pCi/g) for a soil density of 1 gram per square centimeter (g/cm^2) for soils sampled to a depth of 0.318 cm (1/8 in.) (CO73). EPA has not established a standard for plutonium concentration but has proposed a screening level of 44.4 dpm/g (19.98 pCi/g) for a soil density of 1 g/cm^2 for soils sampled to a depth of 1 cm (0.394 in.) (US77).

Radiological Dose Standards

Public Dose Limits

In a memorandum of August 5, 1985, DOE adopted an interim radiation protection standard for DOE environmental activities (VA85). Included is a revision of the dose limits for members of the public. This interim standard incorporates guidance from the NCRP, as well as the EPA Clean Air Act air emission standards for radioactive emissions, as implemented in 40 CFR 61, Subpart H (US83, US85) and modified December 15, 1989, effective in 1990. Table D-1 summarizes the interim radiation dose limits for members of the public. Tables of radiation dose conversion factors to be used for calculating dose from intakes of radioactive materials were published by DOE in July 1988 (US88a, US88b). The dose factors are based on ICRP Publications 30 (IN79) and 48 (IN86) methodology for radiation dosimetry.

Derived Concentration Guides

Effluent air and water DCGs are secondary guides derived from the primary dose standards and are calculated using dose conversion factors and assumed air and water intake rates. Table D-3 includes calculated DCGs for radioactive materials of interest at RFP. DCGs are based on the interim standard dose limit for all pathways of 100 mrem/yr for a 50-yr committed effective dose equivalent. Dose conversion factors provided in the DOE publications are used, and intake rates of 8,400 cubic meters per year (2.66 x 10^4 cubic meters per second [m^3/s]) for air and 730 liters per year (l/yr) (2 x 10^3 ml/d) for water as prescribed by the DOE guidance were assumed for the calculations (US88b).

Radioactivity Concentration Guides (RCG) and Radionuclide Mixtures. RCGs were previous radiation protection standards given in DOE Order 5480.1A, Chapter XI (US81a). These guides included permissible concentrations

of specific radionuclides and mixtures of radionuclides in air (RCG_a) and water (RCG_w) for individuals in the general population (US81a). In addition to restricting specific radionuclides, the guides restricted the concentration of radionuclides in a mixture such that the sum of the ratios of each radionuclide concentration to the appropriate concentration guide would not exceed a value of one. The guides further stated that a radionuclide might be considered not present in a mixture if: (a) the ratio of the concentration of that radionuclide in the mixture to the concentration guide for that radionuclide did not exceed one-tenth, and (b) the sum of such ratios for all radionuclides considered as not present in the mixture did not exceed one-fourth.

Applying the same methodology for reporting mixtures under the DCG concept as was used with RCG, measured concentrations were compared to concentration guides for specific radionuclides rather than to the guide for mixtures. Fractions of ingested radionuclides absorbed in the gastrointestinal tract and the lung clearance classes for inhaled radionuclides were chosen to yield the most restrictive DCGs for comparisons in this report. Where a radionuclide concentration is expressed as the cumulative measurement of more than one isotope, the stated DCG used for comparison represents the most restrictive DCG for that grouping of isotopes.

Plutonium Concentrations. Plutonium concentrations at RFP represent the alpha radioactivity from plutonium isotopes-239 and -240. These constitute over 97% of the alpha radioactivity in plutonium used at the plant.

Uranium Concentrations. Uranium concentrations are the cumulative alpha activity from uranium-233, -234, and -238. Components containing fully enriched uranium are used at the RFP. Depleted uranium metal is fabricated and also is used as a process waste material. Uranium-235 is the major isotope by weight (93%) in fully enriched uranium; however, uranium-234 accounts for approximately 97% of the alpha activity of fully enriched uranium. In depleted uranium, the combined alpha activity from uranium-234 and -238 accounts for approximately 99% of the total alpha activity. Uranium DCGs used in this report for air and water are those for uranium-233, -234, and -238, which are the most restrictive.

Environmental uranium concentrations can be measured by various laboratory techniques. Nonradiological techniques yield concentration units of mass per unit volume such as mg/m^3 and mg/l. Uranium concentrations given in this report were derived by measuring radioactivity from alpha-emitting uranium isotopes and are expressed in terms of activity units per unit volume. Rocky Flats data include measurements of depleted uranium, fully enriched uranium, and natural uranium.

Conversion factors for specific types of uranium can be used to compare the data in this report to data from other facilities and agencies that are given in units of mass per unit volume; however, the resulting approximations will not have the same assurance of accuracy as that of the original measured values. Uranium in effluent air from plant buildings is primarily depleted uranium. The conversion factor for these data is 2.6 X 10^6 Ci/g. Natural uranium is the predominant species found in water. The conversion factor for water data is 1.5 X 10^6 Ci/g.

Table D-4

NPDES Discharge Limitations for the Rocky Flats Plant in 1989

Parameter	Monthly Average	Weekly Average	Daily Maximum
Effluent Water Samples (Nonradioactive)			
pH		6.0-9.0 SU	
Nitrates as N	10 mg/l	20 mg/l	NA
Total Phosphorus	8 mg/l	NA	12 mg/l
Biochemical Oxygen Demand, 5-Day	10 mg/l	NA	25 mg/l
Suspended Solids	30 mg/l	45 mg/l	NA
Total Chromium	0.05 mg/l	NA	0.1 mg/l
Residual Chlorine	NA	NA	0.5 mg/l
Oil and Grease	NA	NA	Visual
Fecal Coliform - No./100 ml	200	400	NA

a. These limitations are presented as indicators of the types of parameters and associated concentration limits required by the NPDES permit. Details of these requirements specific to each discharge location are given in the referenced document (US84a). The daily and monthly limitations indicated cannot be correlated with the annual water quality data summarized in the text.

TABLE D-5a

Colorado Water Quality Control Commission Temporary Water Quality Standards for Offsite Discharge (Adopted July 11, 1989)

All Tributaries to Standley Lake and Great Western Reservoir from RFP:

Chemical Classification	Parameter	CWCC Standards (mg/l)
Physical and Biological	Dissolved Oxygen	5.0
	pH	6.5 - 9.0
	Fecal Coliforms	2000/100
Inorganic	Cyanide	.2
	Sulfate as Hydrogen Sulfide	.05
	Nitrite	1.0
	Nitrate	10.0
	Chloride	250.0
	Sulfate	250.0
	Boron	.75
Metals	Arsenic	.05
	Cadmium	.01
	Copper III	.05
	Copper VI	.05
	Copper	.2
	Iron	.3
	Lead	.05
	Manganese	.05
	Mercury	.002
	Selenium	.01
	Silver	.05
	Zinc	2.0
	Beryllium	.1
	Nickel	.2

TABLE D-5b

Temporary Standards for Carcinogenic Organic Chemicals[c] (Adopted July 11, 1989)

Parameter	CAS No.[f]	Standard[a] (ug/l)
Aldrin	309-00-2	0.002 (I)[d]
Benzene	71-43-2	5
Benzidine	92-87-5	0.0002 (I)
Carbon Tetrachloride	56-23-5	5
Chlordane	57-74-9	0.03 (I)
Chloroethyl Ether (BIS-2)	111-44-4	0.03 (I)
DDT	50-29-3	0.1 (I)
Dichloroethane 1, 2	107-06-2	5
Dichloropropane 1, 2	78-87-5	0.56 (L)[e]
Dieldrin	60-57-1	0.002 (I)
Dioxin (2, 3, 7, 8-TCDD)	1746-01-6	2.2×10^{-7} (L)
Diphenylhydrazine 1, 2	122-66-7	0.05 (I)
Heptachlor	76-44-8	0.008 (L)
Heptachlor Epoxide	1024-57-3	0.004 (L)
Hexachlorobenzene	118-74-1	0.02 (I)
Hexachlorocyclohexane (Lindane)	58-89-9	4
Polychlorinated Biphenyls (PCBs)	1336-36-3	0.005 (I)
Toxaphene	8001-35-2	5
Trichloroethylene	79-01-6	5
Trichlorophenol 2, 4, 6	88-06-2	2.0 (I)
Trihalomethanes (total)[b]		100
Vinyl Chloride	75-01-4	2

a. Standards are based on the Maximum Contaminant Level (MCL) for drinking water unless otherwise noted.
b. Total trihalomethanes are considered the sum of the concentrations of bromodichloromethane (CAS No. 75-27-4), dibromochloromethane (CAS No. 124-48-1), tribromomethane (bromoform, CAS No. 75-25-2) and trichloromethane (chloroform, CAS No. 67-66-3).
c. Organic chemicals not on this list are covered under Section 3.1.11 (1) (d) of "The Basic Standards and Methodologies for Surface Water" (5CFR 1002-8).
d. (I) - Based on 10^{-6} cancer risk from EPA Integrated Risk Information System.
e. (L) - Based on EPA lifetime drinking water health advisory.
f. CAS No. - Chemical Abstracts Service identification number.

TABLE D-5c

Temporary Standards for Non-Carcinogenic Organic Chemicals[a] (Adopted July 11, 1989)

Parameter	CAS No.[e]	Standard (ug/l)
Aldicarb	116-06-3	10 (L)[c]
Carbofuran	1563-66-2	36 (L)
Chlorobenzene	108-90-7	300 (L)
Dichlorobenzene 1, 2	95-50-1	620 (L)
Dichlorobenzene 1, 3	541-73-1	620 (L)
Dichlorobenzene 1, 4	106-46-7	75 (M)[b]
Dichloroethylene 1, 1	75-35-4	7 (M)
Dichloroethylene 1, 2-Cis	156-59-2	70 (L)
Dichloroethylene 1, 2-Trans	156-60-5	70 (L)
Dichlorophenol 2, 4	120-83-2	21 (L)
Dichlorophenoxyacetic Acid (2, 4-D)	94-75-7	100 (M)
Endrin	72-20-8	0.2 (M)
Ethylbenzene	100-41-4	680 (L)
Hexachlorobutadiene	87-68-3	14 (I)[d]
Hexachlorocyclopentadiene	77-47-4	49 (I)
Isophorone	78-59-1	1,050 (I)
Methoxychlor	72-43-5	100 (M)
Nitrobenzene	98-95-3	3.5 (I)
Pentachlorobenzene	608-93-5	6 (I)
Pentachlorophenol	87-86-5	200 (L)
Tetrachlorobenzene 1, 2, 4, 5	95-94-3	2 (I)
Tetrachloroethylene	127-18-4	10 (L)
Toluene	108-88-3	2,420 (L)
Trichloroethane 1, 1, 1	71-55-6	200 (M)
Trichloroethane 1, 1, 2	79-00-5	28 (I)
Trichlorophenol 2, 4, 5	85-95-5	700 (I)
Trichlorophenoxypropionic Acid (2, 4, 5-TP)	93-72-1	10 (M)

a. Organic Chemicals not on this list are covered under section 3.1.11 (1) (d) of the Basic Standards and Methodologies for Surface Water (5CFR 1002-8).
b. M - Based on MCL for drinking water.
c. L - Based on EPA lifetime drinking water health advisory.
d. I - Based on reference dose from EPA Integrated Risk Information System (IRIS).
e. CAS No. - Chemical Abstracts Service identification number.

TABLE D-5d

Temporary Fish and Water Ingestion Standards (Adopted July 11, 1989)

Parameter	Standard µg/l
Acrylonitrile	0.058
Aldrin	0.000074
Benzidine	0.00012
Chlordane	0.00046
Chloroform	0.19
Chloromethyl Ether (BIS)	0.0000037
DDT	0.000024
Dichlorobenzidine	0.01
Dieldrin	0.000071
Dioxin (2, 3, 7, 8-TCDD)	0.000000013
Halomethanes	0.19
Heptachlor	0.00028
Hexachloroethane	1.9
Hexachlorobenzene	0.00072
Hexachlorobutadiene	0.45
Hexachlorocyclohexane, Alpha	0.0092
Hexachlorocyclohexane, Beta	0.0163
Hexachlorocyclohexane, Gamma	0.0186
Hexachlorocyclohexane, Technical	0.0123
Nitrosodibutylamine N	0.0064
Nitrosodiethylamine N	0.0008
Nitrosodimethylamine N	0.0014
Nitrosodiphenylamine N	4.9
Nitrosopyrrolidine N	0.016
PCBs	0.000079
Polynuclear Aromatic Hydrocarbons	0.0028
Tetrachloroethane 1, 1, 2, 2	0.17
Tetrachloroethylene	0.8
Trichloroethane 1, 1, 2	0.6
Trichlorophenol 2, 4, 6	1.2

TABLE D-5e

Temporary Radionuclide Standards for State Surface Waters (Adopted July 11, 1989)

Parameter	pCi/l
Americium-241	30
Curium-244	60
Neptunium-237	30
Plutonium-241	1,000
Plutonium-242	30
Uranium (total of all isotopes)	40

Note that the following radionuclide standards have previously been adopted and are in effect for all state surface waters:

Cesium-134	80
Plutonium-238, -239, and -240	15
Radium-226 and -228	5
Strontium-90	8
Thorium-230 and -232	60
Tritium	20,000

APPENDIX E

ANALYTICAL PROCEDURES

Health, Safety and Environmental Laboratories (HS&E Laboratories)

HS&E Laboratories routinely perform the following analyses on environmental and effluent samples:

1. Total Air Filter Counting (Pu specific alpha)
2. Gas Proportional Counting (Gross alpha & gross beta)
3. *Gamma Spectral Analysis*
4. Alpha Spectral Analysis (Pu-239, -238; Am-241; U-238, -233, -234)
5. Beta Liquid Scintillation (Tritium)
6. N,N-Dimethyl-p-phenylenediamine (DPD) (Chlorine)
7. Atomic Absorption (Beryllium)
8. Millipore Filtration Method (Fecal and Total Coliform)

Procedures for these analyses are described in the "HS&E Laboratories Procedures and Practices Manual," (WI82). The procedures for bacteria and chlorine analyses were developed following EPA guidelines. Soil procedures were developed following specifications set forth in "Measurements of Radionuclides in the Environment, Sampling and Analysis of Plutonium in Soil," Nuclear Regulatory Commission Reg. Guide 4.5. All new procedures and changes to existing procedures must be thoroughly tested, documented, and approved in writing by the Manager of HS&E Laboratories before being implemented. Environmental Management is notified of any major changes that could affect analytical results. All procedures are reviewed annually for consistency with state-of-the-art techniques, or at any time an analytical problem is suspected. Copies of all procedures are kept on file in the office of the manager of HS&E Laboratories.

Analytical Procedures

Samples received for air filter screening are counted at approximately 24 hrs and then 48 hrs after collection. Samples exceeding specified limits are recounted. If the total long-lived alpha concentration for a screened filter exceeds these EM action limits, the filter is directed to individual specific isotope analysis and/or follow-up investigation to determine the cause and any needed corrective action.

All water samples, except those scheduled for tritium analysis, are poured into one-liter Marinelli containers and sealed before delivery to the gamma counting area. Routine water samples are counted for approximately 12 hrs. Samples requiring a lower detection limit are counted from 16 to 72 hrs.

Soil samples scheduled for gamma spectral analysis are dried, sieved through a ten-mesh sieve, weighed, and the fine portion is ball-milled. The fine portion is then placed in a 500-milliliter (ml) Marinelli container and counted for at least 16 hrs.

All samples scheduled for alpha spectral analysis are analyzed in a similar manner regardless of matrix. Prior to dissolution, a known quantity of nonindigenous radioactive tracer is added to each sample. The tracer is used to determine the chemical recovery for the analysis. Tracers used include Pu-236, Pu-242, U-232, U-236, Am-243, and Cm-244. The type and activity level of the tracer used depends on the type and projected activity level of the sample to be analyzed. All

refractory or intractable actinides are dissolved by vigorous acid treatment using both oxidizing and complexing acids. After samples are dissolved, the radioisotopes of concern are separated from each other and from the matrix material by various solvent extraction and ion exchange techniques. The purified radioisotopes are electro-deposited onto stainless steel discs. These discs are alpha counted for 12 hrs. If a lower minimum detection limit is required, samples may be counted from 72 to 168 hrs. depending on the specific sensitivity requirement. Samples that exhibit a chemical recovery of less than 10% or greater than 110% are automatically scheduled for reanalysis.

Tritium analyses are routinely performed on specified environmental water samples as well as stack effluent samples. Ten ml of the samples are combined with 10 ml of liquid scintillation fluid. Environmental and airborne effluent samples are generally counted for 120 min.

General Laboratory

The General Laboratory routinely performs the following analyses for environmental monitoring of plant effluent streams, process wastes, and soil residues:

1. Dissolved metallic elements including tests for 19 cations by inductively coupled plasma spectroscopic techniques and 17 elements by atomic absorption spectroscopy techniques (including beryllium in airborne effluent sample filters).

2. Oxygen demand tests including total organic carbon, dissolved oxygen, chemical oxygen demand, carbonaceous biological oxygen demand, and biological oxygen demand (5-day incubation).

3. Nutrient tests including free ammonia, ortho and total phosphate phosphorus, nitrite and nitrate anions.

4. Physical tests, including pH, conductivity, color, total dissolved solids, suspended solids, total solids, nonvolatile suspended solids, turbidity, and specific gravity.

5. Soap residues (as alkyl sulfonate).

6. Oil and grease residues, by extraction and infrared or gravimetric detection and by visual observation.

7. Specific chemical property or element including total hardness (as calcium carbonate), alkalinity (as hydroxide, bicarbonate, or carbonate), chloride, fluoride, cyanide, sulfate, and hexavalent chromium.

8. Radioactive species including gross alpha and beta by gas proportional detection; tritium by liquid scintillation detection; total radiostrontium by gravimetric separation followed by gas proportional detection. Isotopes of plutonium, americium, and uranium are determined by ion exchange and liquid extraction techniques followed by alpha pulse height analysis.

9. Volatile and semi-volatile compounds from the EPA Contract Laboratory Program (EPA-CLP) Target Compound List are analyzed by gas chromatography/mass spectrography. Phenols also are analyzed using spectrophotometry. Polychlorinated biphenyl compounds are analyzed by gas chromatography.

Procedures for these analyses, developed by the General Laboratory analytical technical staff, were adopted from EPA-approved sources or from other recognized authoritative publications where EPA-approved procedures were not available. Laboratory operations procedures are documented in a standard format, approved by the manager of the Rocky Flats Analytical Laboratories, and distributed to a controlled distribution list to assure that proper testing and approval is performed before changes are adopted. The General Laboratory Quality Assurance Plan requires annual review of procedures for consistency with state-of-the-art techniques and compliance of laboratory practice with written procedures. In addition, a review is performed whenever an analytical problem is indicated.

Analytical Procedures

All water samples analyzed for radioactive materials, except those scheduled for tritium analysis, are acidified immediately upon collection.

Liquid samples received for gross alpha and beta screening are evaporated, and the residue is transferred to planchets for gas proportional counting. When activities exceed action guidelines, notification to EM is made, and reanalysis and/or investigation may be required.

For some liquids such as machine oils, a specified volume is evaporated, ashed, and the salt residue is taken up in nitric acid for deposition onto the counting planchet. A correction factor is determined for each sample to account for self-absorption effects.

Water samples to be tested for chemical and physical parameters are analyzed within 24 hrs. of collection, or they are preserved by refrigeration, freezing, or addition of a chemical preservative when required. The tests performed include gravimetric, titrametric, calorimetric, chromatographic, or electroanalytical methods, following procedures specified in the 16th edition of Standard Methods for the Examination of Water and Waste Water, Methods for Chemical Analysis of Water and Wastes, or other authoritative publications.

Water samples to be analyzed for dissolved metallic ions are filtered through a 0.45 µm filter, preserved with nitric acid, and digested before being analyzed by atomic absorption or ICP methods.

Organic toxic species are determined by chromatography, using electron capture detection. Some organics, such as phenol, are determined by developing a chromaphoric complex and measuring light absorption at a specific wave-length with a spectrophotometer. Measuring occurs after extraction into an appropriate solvent phase.

Tritium is measured using liquid scintillation counting. Counting efficiency is determined using a separately prepared vial to which is added a known standard tritium activity.

Strontium is radiochemically separated from the sample matrix using precipitation techniques. Strontium is deposited on planchets with a carrier element, and the activity in the sample is quantified using beta gas proportional counting.

APPENDIX F

DETECTION LIMITS AND ERROR TERM PROPAGATION

Radioactivity Parameters

Health, Safety and Environmental Laboratories have adopted the following definition for detection limit, as given by Harley (HA72):

"The smallest amount of sample activity using a given measurement process (i.e., chemical procedure and detector) that will yield a net count for which there is confidence at a pre-determined level that activity is present."

The minimum detectable amount (MDA) is the term used to describe the detection limit and is defined as the smallest amount of an analyzed material in a sample that will be detected with a β probability of non-detection (Type II error), while accepting an α probability of erroneously detecting that material in an appropriate blank sample (Type I error). At the 95% confidence level, both α and β are equal to 0.05.

Based on the approach presented in draft American National Standards Institute Standard N13.30, "Performance Criteria for Radiobioassay," (HE85) the formulation of the MDA for radioactive analyses is:

$$MDA = \frac{4.65\, S_B + 3/(T_s E_s Y)}{aV}$$

where S_B = standard deviation of the population of appropriate blank values (disintegrations per minute, d/m)

T_s = sample count time (minutes, m)

E_s = absolute detection efficiency of the sample detector

Y = chemical recovery for the sample

a = conversion factor (disintegrations per minute per unit activity)

(a = 2.22 disintigrations per minute per picocurie [d/m/pCi] when MDA is in units of pCi, and a = 2.22×10^6 disintigrations per minute per microcuries [d/m/μCi] when MDA is in units of μCi.)

V = sample volume or weight
(V=1 if the MDA per sample is desired.)

The major component of the MDA equation is the variability of the blanks.

Table F-1 shows the various formulas used for alpha data reduction during 1988.

Table F-2 shows the typical MDA values for the various analyses performed by the HS&E Laboratories and by the General Laboratories. These values are based on the average sample volume, typical detector efficiency, detector background, count time, and chemical recovery. MDA values calculated for individual analyses may vary significantly depending on actual sample volume, chemical recovery, and analytical blank used.

Nonradioactivity Parameters

For nonradioactivity parameters, various means are used to estimate an MDA depending on the parameter measured. The MDA for beryllium in effluent air, analyzed using flameless atomic absorption spectroscopy, is based on a sample blank absorbance reading. Total chromium in effluent water samples undergoes a fourfold concentration of the received sample prior to its analysis using flame atomic absorption spectroscopy. Its approximate MDA is based on a net sample absorbance reading of 0.010.

The parameters of nitrate as N, total phosphorous, suspended solids, oil and grease, and total organic carbon all have MDAs determined by procedural methods found in EPA-600, "Methods for Chemical Analysis of Water and Wastewater" (US87c). Biochemical oxygen demand and pH have MDAs determined by the minimal readout capability of the instrumentation that is used.

The MDA for residual chlorine is determined by the procedure found in a publication by Hach Co., "DPD Method for Chlorine" (HA83). For fecal coliform count, MDA is calculated as 4.65 times the standard deviation of the blank value from the millipore filter.

Table F-1

Formulas for Activity and Uncertainty Calculations for the Alpha Spectral Analysis Systems

Non-Blank Corrected Sample Activity

$$ {}^{A}si = \left[\frac{\frac{{}^{C}si}{{}^{T}s} - \frac{{}^{C}Bi}{{}^{T}B}}{\frac{{}^{C}sj}{{}^{T}s} - \frac{{}^{C}Bj}{{}^{T}B}} \right] \frac{{}^{D}sj}{V \cdot 2.22} $$

Blank Corrected Sample Activity

$$ {}^{B}si = {}^{A}si - {}^{A}ri $$

Non-Blank Corrected Sample Uncertainty*

$$ {}^{*}si = {}^{A}si \left[\frac{\frac{{}^{C}si}{{}^{T}s^2} + \frac{{}^{C}Bi}{{}^{T}B^2}}{\left[\frac{{}^{C}s}{{}^{T}s} - \frac{{}^{C}Bi}{{}^{T}B}\right]^2} + \frac{\frac{{}^{C}sj}{{}^{T}s^2} + \frac{{}^{C}Bj}{{}^{T}B^2}}{\left[\frac{{}^{C}sj}{{}^{T}s} - \frac{{}^{C}Bj}{{}^{T}B}\right]^2} \right]^{1/2} $$

Blank Corrected Sample Uncertainty

$$ {}^{b}si = ({}^{a}si^2 + {}^{a}ri^2)^{1/2} $$

*Corrected from 1984 report

Legend

- ${}^{A}ri$ = Non-blank corrected activity of laboratory reagent blank for isotope i expressed as picocuries (pCi) per unit volume.
- ${}^{a}ri$ = Non-blank corrected uncertainty of laboratory reagent blank expressed as pCi per unit volume.
- ${}^{A}si$ = Sample activity for isotope i expressed as pCi per unit volume.
- ${}^{*}si$ = Sample activity uncertainty expressed as pCi per unit volume.
- ${}^{B}si$ = Blank corrected sample activity for isotope i expressed as pCi per unit volume.
- ${}^{b}si$ = Blank corrected sample uncertainty expressed as pCi per unit volume.
- ${}^{D}sj$ = Activity (dpm) of internal standard isotope j added to sample.
- ${}^{C}si$ = Sample gross counts for isotope i.
- ${}^{C}sj$ = Sample gross counts for internal standard isotope j.
- ${}^{C}Bi$ = Detector background gross counts for isotope i.
- ${}^{C}Bj$ = Detector background gross counts for internal standard isotope j.
- ${}^{T}s$ = Sample count time expressed in minutes.
- ${}^{T}B$ = Detector background count time expressed in minutes.
- V = Sample unit volume or sample unit weight.

Table F-2

Detection Limits for Radioactive and Nonradioactive Materials

Parameter	Minumum Detectable Activity (per sample)	Approximate Sample Volume Analyzed[a]	Minimum Detectable Activity (per unit volume or mass)
Airborne Effluents			
Plutonium-239,-240	6.2×10^{-8} µCi	7,340m^3 [b]	0.008×10^{-15} µCi/ml
Uranium-233,-234,-238	5.7×10^{-7} µCi	7,340m^3 [b]	0.08×10^{-15} µCi/ml
Americium-241	1.0×10^{-7} µCi	7,340m^3 [b]	0.01×10^{-15} µCi/ml
Tritium (H-3)	2.5×10^{-5} µCi	1.4m^3	$16{,}000 \times 10^{-15}$ µCi/ml
Beryllium	2.5×10^{-1} µCi	7,340m^3 [b]	3.0×10^{-5} µg/m^3
Ambient Air Samples			
Plutonium-239,-240	1.2×10^{-7} µCi	29,000m^3 [c]	0.004×10^{-15} µCi/ml
Effluent Water Samples (Radioactive)			
Plutonium-239,-240	7.1×10^{-8} µCi	5,000 ml	0.01×10^{-9} µCi/ml[c]
Uranium-233,-234,-238	2.9×10^{-7} µCi	1,000 ml	0.29×10^{-9} µCi/ml[c]
Americium-241	9.4×10^{-8} µCi	5,000 ml	0.02×10^{-9} µCi/ml[c]
Tritium (H-3)	2.5×10^{-6} µCi	10 ml	250×10^{-9} µCi/ml[c]
Soil Samples (Radioactive)			
Plutonium-239,-240	8.4×10^{-8} µCi	10 g	8.4×10^{-9} µCi/g
Effluent Water Samples (Nonradioactive)			
pH		100 ml	0-14 SU
Nitrates as N		4 ml	0.02 mg/l
Total Phosphorus		50 ml	0.2 mg/l
Biochemical Oxygen Demand, 5-Day		300 ml	5.0 mg/l
Suspended Solid		100 ml	1.0 mg/l
Total Chromium		100 ml	0.05 mg/l
Residual Chlorine		10 ml	0.1 mg/l
Oil and Grease		1,000 ml	0.5 mg/l
Fecal Coliform Count		10-100 ml	43 organisms/100 ml
Total Organic Carbon		5 ml	1.0 mg/l

a. Volume analyzed is usually an aliquoted fraction of the total sample volume collected.
b. Monthly composite.
c. Composite of two biweekly samples.

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REPORTING OF MINIMUM DETECTABLE CONCENTRATION AND ERROR TERMS

Plutonium, uranium, americium, and beryllium measured concentrations are reported. These reported concentrations include values that are less than the corresponding calculated minimum detectable concentration and in some cases, values less than zero. Negative values result when the measured value for a laboratory reagent blank is subtracted from an analytical result that was measured as a smaller value than the reagent blank. These resulting negative values are included in any arithmetic calculations on the data set.

Error terms in the form of a±b are included with some of the data. For a single sample, "a" is the reagent blank corrected value; for multiple samples it represents the average value (arithmetic mean). The error term "b" accounts for the propagated statistical counting uncertainty for the sample and the associated reagent blanks at the 95% confidence level. These error terms represent a minimum estimate of error for the data.

APPENDIX H

METRIC FRACTIONS

Multiple	Decimal Equivalent	Prefix	Symbol
10^{6}	1,000,000	mega-	M
10^{3}	1,000	kilo-	k
10^{2}	100	hecto-	h
10	10	deka-	da
10^{-1}	0.1	deci-	d
10^{-2}	0.01	centi-	c
10^{-3}	0.001	milli-	m
10^{-6}	0.000001	micro-	μ
10^{-9}	0.000000001	nano-	n
10^{-12}	0.000000000001	pico-	p
10^{-15}	0.000000000000001	femto-	f
10^{-18}	0.000000000000000001	atto-	a

APPENDIX I

METRIC CONVERSION TABLE

Multiply	By	Equals	Multiply	By	Equals
in.	2.54	cm	cm	0.394	in.
ft	0.305	m	m	3.28	ft
ac	0.404	ha	ha	2.47	ac
mi	1.61	km	km	0.621	mi
lb	0.4536	kg	kg	2.205	lb
liq. qt. - U. S.	0.946	l	l	1.057	liq. qt. - U. S.
ft^2	0.093	m^2	m^2	10.764	ft^2
mi^2	2.59	km^2	km^2	0.386	mi^2
ft^3	0.028	m^3	m^3	35.31	ft^3
d/m	0.450	pCi	pCi	2.22	d/m
pCi/l (water)	10^{-9}	µCi/ml (water)	µCi/ml (water)	10^{9}	pCi/l (water)
pCi/m^3 (air)	10^{-12}	µCi/cc (air)	µCi/cc (air)	10^{12}	pCi/m^3 (air)

TRADITIONAL AND INTERNATIONAL SYSTEMS OF RADIOLOGICAL UNITS

APPENDIX J

(Traditional units are in parentheses.)

Quantity	Name	Symbol	Expression in Terms of Other Units
absorbed dose	Gray	Gy	J/Kg^{-1}
	(rad)	rad	10^{-2} Gy
activity	Bequerel	Bq	1 dps
	(curie)	Ci	3.7×10^{10} Bq
dose equivalent	Sievert	Sv	J/Kg^{-1}
	(rem)	rem	10^{-2} Sv
exposure	Coulomb per kilogram		C/Kg^{-1}
	(roentgen)	R	2.58×10^{-4} C/Kg^{-1}

This publication was printed at the UNICOR Print Plant, Federal Correctional Institution, Petersburg, VA

U.S. DEPARTMENT OF ENERGY/ROCKY FLATS PLANT SITE
ENVIRONMENTAL REPORT FOR 1989 (RFP-ENV-89)

Attached for your information is the 1989 Site Environmental Report for the Rocky Flats Plant. In addition to summaries of radiological and nonradiological monitoring in the vicinity of and on the Rocky Flats Plants (RFP), the report includes summaries of environmental activities on the site, a listing of the major environmental permits along with the compliance status of each, and description of National Environmental Policy Act activities.

We have also attached an environmental compliance self assessment covering the period of January 1, 1990, to May 1, 1990. This is representative of our ongoing program to place greater emphasis on identifying potential environmental compliance issues at RFP and developing solutions to those problems.

Robert M. Nelson, Jr.
Manager

Attachment

ENVIRONMENTAL COMPLIANCE ASSESSMENT - ROCKY FLATS PLANT SITE

January 1, 1990 - May 1, 1990

COMPLIANCE SUMMARY

National Environmental Policy Act (NEPA)

The draft Environmental Assessment (EA) for the Supercompactor and Repackaging Facility and Tru Waste Shredder (DOE/EA-0432) was made available for public comment March 30 - April 30, 1990. EG&G Rocky Flats, Inc., is responding to public comments received during this period. The Department of Energy (DOE) has proposed a Finding of No Significant Impact for this facility. The draft EA for the 881 Hillside (DOE/EA-0413) was finalized by DOE in January 1990.

Clean Air Act

The "Air Emissions Annual Report for 1989 - 40 CFR 61.96" was completed April 30, 1990, and will be submitted to the Environmental Protection Agency (EPA) by June 1, 1990. The report provides information on radioactive air emissions and projected radiation doses to the maximally exposed member of the public resulting from the Rocky Flats Plant (RFP) during 1989.

RFP contracted with Martin Marietta Energy Systems, Inc., in March 1990 to conduct compliance testing for beryllium emissions. A plan for sampling emissions was prepared by the contractor, and Colorado Department of Health (CDH) approved this plan in April 1990. Testing, scheduled for mid-May, will determine maximum emissions during 24-hr sample periods in accordance with EPA methods.

CDH provided specific guidelines for Air Pollution Emission Notices (APENs) for RFP in January 1990. An APEN is required for any process or activity that has the potential of: 1) an uncontrolled emission that is greater than one pound per day for any hazardous or toxic pollutant; 2) an uncontrolled emission that is greater than one ton per year for any pollutant; or 3) an emission arising from storage and transfer facilities and surface coating processes, per Air Quality Control Commission Regulation No. 7.

On March 9, 1990, RFP initiated a vent survey and chemical analysis of 104 process and support buildings to determine which facilities require APENs and/or air emissions permits. The survey is being conducted in accordance with the Agreement in Principle between DOE and the State of Colorado and is scheduled to be completed by late December 1990. APENs were submitted for the following sites from January 1, 1990, through May 1, 1990:

Site	Description
779-44	Emergency generator, non-process area
779-729	Emergency generator, filter plenum
779-782	Emergency generator, filter plenum
886	Uranium solution evaporator
Various Locations	Pondcrete shelters

A Notice of Violation (NOV) was received from CDH on April 11, 1990, for failure to have a submerged fill tube and vapor control system for an underground gasoline storage tank. A later inspection by CDH revealed that the appropriate equipment was present on this facility. A second NOV was also received April 11, 1990, for failure to have APENs or air emission permits for two spray paint booths and a shot blaster. CDH issued an Order for Compliance on May 1, 1990. Actions are being taken by RFP to resolve this NOV.

Clean Water Act

The Colorado Water Quality Control Commission (CWQCC) adopted final standards for Walnut Creek and Woman Creek on March 30, 1990. These standards supercede former temporary standards adopted July 1989.

Following a hiatus of approximately 6 months, RFP began to discharge water from surface water control ponds A4, B5, and C2 in March 1990. Discharges were treated by particle filtration and granular activated carbon filtration and were within limits of the National Pollutant Discharge Elimination System (NPDES) and CWQCC water quality standards.

Toxic Substances Control Act (TSCA)

RFP published "Toxic Substance Control Act Standard Operating Procedures" on March 31, 1990. This manual describes procedures for managing polychlorinated biphenyls and asbestos materials at RFP.

Resource Conservation and Recovery Act (RCRA)

RFP submitted comments on March 30, 1990, on a Notice of Intent to Deny (NOID) issued by CDH for 11 of 20 hazardous and low-level mixed waste units included in a RCRA Part B permit application. These comments are being reviewed by CDH. CDH prepared a draft RCRA permit for the remaining nine waste units in 1989.

The Part B permit application for transuranic mixed waste is being revised to include the Supercompactor and Repackaging Facility and Tru Waste Shredder. The revision is scheduled to be filed by the end of May 1990.

An annual RCRA ground water monitoring report for the Solar Evaporation Ponds, West Spray Field and Present Landfill areas was submitted March 1, 1990. This report summarizes ground water activities and data for 1989.

Notice of Violation #90-03-28-01 was received from CDH on March 28, 1990, for deficiencies in the "Ground Water Assessment Plan for Rocky Flats" submitted September 1989 by RFP. This plan was prepared in response to Compliance Order 89-06-07-01 issued by CDH in June 1989. RFP is preparing an addendum to address deficiencies in the assessment plan.

On April 12, 1990, a U.S. district court ruled that plutonium residues which theretofore were not considered to be RCRA regulated by the DOE, were found to be RCRA regulated if they: 1) contained a listed hazardous waste constituent; or 2) met one of four hazardous waste characteristics. In response to this order, it is anticipated RFP will pursue an addendum to Settlement Agreement and Compliance Order on Consent #89-10-30-01 or will negotiate a new compliance agreement with CDH.

Federal Facilities Compliance Agreement (FFCA)and Compliance Order on Consent

FFCA provides a 1-yr period for DOE to work toward compliance with land disposal restrictions of the Hazardous and Solid Waste Amendments of 1984. The following documents were submitted to EPA in 1990 in compliance with this agreement: "National Report on Prohibited Waste and Treatment Options" (January 17, 1990); "Land Disposal Restriction (LDR) Determination Report" (March 18, 1990); "Waste Minimization Assessment Report Amendments" (March 18, 1990); and "Treatment Plan No. 1" (March 16, 1990).

Settlement Agreement and Compliance Order on Consent #89-10-30-01

This agreement requires DOE to submit plans for residue classification, residue characterization, and RCRA compliance. The following documents were submitted to CDH in 1990 in compliance with this agreement: "Residue Classification Plan" (January 31, 1990); "Process Description Report" (February 1, 1990); "Compliance Evaluation Report/Interim Compliance Plan" (March 2, 1990); and "Residue Characterization Plan" (March 30, 1990).

Comprehensive Environmental Response, Compensation and Liability Act (CERCLA)

The final "Interim Measures/Interim Remedial Action Plan and Decision Document" for the 881 Hillside was completed in January 1990. Construction activities began on January 15, 1990, but were suspended temporarily in March 1990 by EG&G Management because of concerns regarding procedures for the supervision and documentation of construction activities. Documentation procedures were modified to address these concerns. Restart of construction is scheduled for May 1990.

The "Phase II Remedial Investigation/Feasibility Study" work plan for the 903 Pad, Mound, and East Trenches areas was submitted to EPA on April 12, 1990.

Emergency Planning and Community Right-to-Know Act (EPCRA)

The "Tier II Emergency and Hazardous Chemical Inventory Forms" report was submitted on March 1, 1990, to the Colorado Emergency Planning Commission, Jefferson County Emergency Planning Committee, Boulder County Emergency Planning Committee, and the Rocky Flats Fire Department. This report lists quantities and locations of hazardous chemicals at RFP.

Interagency Agreement (IAG)

Renegotiation of the proposed IAG began in early 1990 following receipt of public and agency comments on a draft of the agreement submitted for review in December 1989. A revised agreement was published August 17, 1990. Notable changes in this agreement from the earlier version are the following:

1) the re-ordering of Operable Units (O.U.s) to emphasize attention to "off-site" areas (i.e., areas located east of Indiana Street)

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2) the increase in the number of O.U.s from 10 to 16 to better focus on the unique characteristics of different restoration areas. Former groupings of sites into O.U.s included dissimilar sites requiring different remedial actions.

Compliance actions required by the IAG are being implemented, although approval of the final agreement is pending. This is being done on the basis of a common understanding of remediation sites requiring immediate attention. During the period January 1, 1990, to November 1, 1990, more than 20 documents were prepared on current or planned remedial activities. These documents cover a range of topics including remedial investigation workplans, interim remedial action decisions, community survey plans, project management plans, and health and safety plans. A list of these documents is given in the milestone schedule (Table 6) of the IAG.

U.S. Department of Justice Investigation

On June 6, 1989, the United States Department of Justice, in conjunction with the State of Colorado and other federal agencies, initiated a comprehensive investigation into environmental and waste management activities at the Rocky Flats Plant. Currently, DOE and contractor personnel are cooperating fully with the grand jury investigators looking into these matters.

CURRENT ISSUES AND ACTIONS

Special Assignment Team

EG&G Rocky Flats responded to findings of DOE's Special Assignment Team on March 2, 1990. The response was given in the form of an action plan that included descriptions of corrective measures, schedules, milestones, associated costs, and parties responsible for implementing planned actions. The Special Assignment Team was mobilized in June 1989 to provide an independent evaluation of operations and practices at RFP.

Site-Specific Plan

A Site-Specific Plan (SSP) for RFP was completed in February 1990. The SSP describes plans for implementing activities in the RFP Five-Year Plan (FYP) with emphasis on near-term activities, primarily those to be accomplished in fiscal year 1990. The FYP encompasses total program activities and costs for DOE corrective activities, environmental restoration, waste management, and applied research and development.

ENVIRONMENTAL PERMITS

RFP holds environmental permits for water and air emissions and has applications pending for management of hazardous and mixed wastes as described in Table 2.0-1 of the "Rocky Flats Plant Site Environmental Report for 1989." The status of permits and permit applications is unchanged as of May 1, 1990. Additional air emissions permits may be required as the result of the survey of emissions sources (APENs).